THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[THIRD SERIES.]

Art. I.—*On Alpine Geology;** by T. Sterry Hunt.

Since the days of de Saussure, the Alps have been the object of constant study. No other portion of Europe offers so many problems of interest to the geologist and the physical geographer as this great mountain chain, whether we consider its lakes, glaciers and moraines, its curiously disturbed and inverted fossiliferous strata, which seem, at first sight, arranged for the confusion alike of paleontologists and stratigraphists, or the crystalline rocks which form its highest summits. To give a list of the various investigators who have contributed their share to the elucidation of this region would, of itself, be no slight task, and would besides be foreign to our present purpose; which is to call attention to the learned work of Prof. Alphonse Favre of Geneva, in which he has given us the results of more than twenty-five years of labor in the study of Alpine geology, chiefly in Savoy and the adjacent parts of Piedmont and Switzerland, embracing Mont Blanc and its vicinity. It is now twelve years since the present writer had occasion to review in this Journal (II, xxix, 118) some points in Alpine geology raised by our author in his memoir *Sur les terrains liassque et keuperien de la Savoie*, published in 1859. Since that time the views then maintained by Favre, have, in spite of much opposition, gained ground, and are set forth at length in the present work, supported by an amount of evidence which seems convincing. We shall endeavor from

* Recherches Géologiquer dans les parties de la Savoie, du Piémont, et de la Suisse voisines du Mont Blanc, avec un Atlas de 32 planches, par Alphonse Favre, Professeur de Géologie à l'Académie de Genève. 3 vols. 8vo. Paris, 1867.

its pages to present a condensed summary of our present knowledge of the structure of Mont Blanc and the adjacent regions.

The crystalline rocks of the Alps, as first shown by Studer, do not form a continuous chain, but appear as distinct masses, separated from each other by uncrystalline sedimentary deposits, generally fossiliferous. According to Desor, there are between Nice and the plains of Hungary not less than thirty-four such areas, standing up like islands from out of the sedimentary rocks, and presenting for the most part a fan-like structure (*en eventail*). Of these masses of crystalline rock, Mont Blanc is the most remarkable, and is described by Elie de Beaumont as "rising through a solution of continuity in the secondary strata, which may be compared to a great button-hole." The length of this area of crystalline rock, measured from the Col du Bonhomme on the S. W. to Saxon in the Valais on the N. E., is fifty-nine kilometers, while its breadth, from Chamonix on the N. W. to Entrèves near Courmayeur on the S. E., is fourteen kilometers. The length of the central mass of protogine is, however, only twenty-seven kilometers. Of the numerous peaks in this area the highest attains an elevation of 4810 meters above the level of the sea, being 3760 meters above the valley of Chamonix and 3520 meters above the valley of Entrèves. This great mass is described by Favre as supported at the four corners by as many buttresses rising from the surrounding valleys, and known as the Cols de Balme, de Voza, de la Seigne and de Ferret. The distance between the two valleys just named is only 13,500 meters, and the boldness with which the mountain rises from them is strikingly apparent if we take the Col de l'Aiguille du Midi and the Col du Géant, which are about 3460 meters above the sea, and distant from each other 5,000 meters, giving a slope of about 30°. A still greater inclination is obtained if we choose, instead of these, the summits of the Aiguilles which bear the same names, and, although now isolated, represent portions of the former mass of Mont Blanc.

The crystalline rocks of this region present two types, 1st, the protogines which form the center, and 2nd, the crystalline schists which occupy the flanks and form the Aiguilles Rouges. These schists are also found at a great elevation on the mountain; at the Grands Mulets (4666 meters), the rocks are talcose and quartzose schists with graphite, hornblende, epidote, talc, and asbestus, and similar rocks and minerals are found from thence to the summit. The protogines themselves, according to the evidence of nearly all who have studied them, are stratified rocks, gneissic in structure, and pass in places into more schistose varieties, though Favre regards the distinction between these and the crystalline schists proper as one clearly marked.

The outlines presented by the weathering of the protogine are very unlike the rounded forms assumed by true granite rocks. According to Delesse, the rock to which Jurine gave the name of protogine is a talco-micaceous granite or gneiss, made up of quartz, generally more or less grayish or smoky in tint, with orthoclase, grayish or reddish in color, and a white or greenish oligoclase with characteristic striæ, often penetrated with greenish talc. The mica [biotite], which some previous observer had mistaken for chlorite, is dark-green in color, becoming of a reddish bronze by exposure. It is binaxial, nearly anhydrous, and contains a large portion of ferric oxide. The composition of the protogine rock, as a whole, differs from that of ordinary granite, according to Delesse, only in the presence of one or two hundredths of iron-oxide and magnesia. The name of arkesine was given by Jurine to a variety of protogine containing chlorite with hornblende, and sometimes sphene. Among the other crystalline rocks of the Alps are various talcose and chloritic schists, with steatites, chromiferous serpentines, diallage rocks, diorites, and euphotides, associated with beds of petrosilex or eurite, frequently porphyritic. Highly micaceous schists, often quartzose, and holding garnet, staurolite and cyanite, are also met with among the crystalline rocks of the Alps. A great belt of serpentine and chloritic schists, traced for a long distance, may be seen at the base of the Montanvert overlaid by the euritic porphyries into which they appear to graduate, the whole series, here supposed to be inverted, dipping at about 60° from the valley of Chamonix toward Mont Blanc, and overlaid by the more massive gneiss or protogine. The chloritic and talcose schists of the Alps have close resemblances with those of the Urals, and as Damour has shown, contain a great many mineral species in common with them. Favre has moreover remarked the strong likeness between the chloritic and talcose schists and the mica-schists with staurolite of the western Alps and those found in Great Britain.

Granite, though not abundant in the vicinity of Mont Blanc, occurs in several localities, the best known of which is Valorsine, where a porphyroid granite with black mica forms considerable masses, and sends large veins into the adjacent gneiss. These, with others found at the Col de Balme and in the Aiguilles Rouges, appear to be true eruptive granites. Numerous small veins met with among the crystalline schists in the gorge of Trient appear, however, to belong to what I have described as endogenous granites (*Notes on Granite Rocks*, this Jour., II, i, 87). Favre has himself maintained that they are the results of aqueous infiltration, and has noticed the fact of a joint running longitudinally through the middle of many of them as an evidence of this mode of formation.

The uncrystalline strata in the region around Mont Blanc include representatives of the carboniferous, triassic, jurassic, neocomian, cretaceous and tertiary. The existence of an apparently carboniferous flora, and its intimate association with a liassic fauna, has long been a well known fact in Alpine geology. In 1859, Favre pointed out the existence of a zone of triassic rocks in this region represented by red and green shales, with sandstones, gypsum, and a cavernous magnesian limestone (cargneule). These rocks had long before been referred to this period by Buckland and Bakewell, but their horizon was established by the discovery of Favre that their position is intermediate between the carboniferous and the strata containing *Aricula contorta*, the Kössen beds, or the Rhætic beds of Gümbel, which are recognized as forming a passage between the trias and the lias, at the base of the Jurassic system. To these, to the northwest of Mont Blanc, succeed the higher members of the system, followed by the neocomian, the cretaceous and the nummulitic strata of the eocene with overlying sandstones and shales, the flysch of some Alpine geologists.

Few questions in geology have been more keenly debated, or given rise to more often repeated examinations, than the association of a carboniferous flora with liassic belemnites in the districts of Maurienne and Tarentaise, to the southwest of Mont Blanc. As seen at Petit-Cœur, the schists, with impressions of ferns and beds of anthracite, were so long ago as 1828 described by Elie de Beaumont as apparently intercalated in the Jurassic system. Scipion Gras, and Sismonda after him, have agreed in regarding the rocks as constituting one great system, which according to Gras is of carboniferous age, but with a jurassic fauna, while de Beaumont and Sismonda on the contrary, regarded it as of jurassic age, but with a carboniferous flora, and imagined that by some means there had been in this region a local survival of the vegetation of the paleozoic period. These conclusions were accepted by many geologists, though rejected by not a few. A brief account of the controversy up to that date will be found in this Journal for January, 1860, page 120, and in the work of Favre now before us the whole matter is discussed at great length in chapter xxx. The anthracitic system of the Alps, as recognized by Gras, was by him estimated to have a thickness of from 25,000 to 30,000 feet, and included besides the dolomites and gypsums now referred by Favre to the trias, coal-plants and layers of anthracite, together with limestones holding belemnites of jurassic age. Included in this great system were, moreover, gneissic, micaceous and talcose rocks, with graphite, serpentine, euphotide, etc., all of which were regarded by Gras as formed by the local alteration of portions of the anthracitic system. To this was added in 1860 the

discovery by Pillet of nummulitic beds intercalated in the same series near St. Julien in Maurienne. This fact was, however, in accordance with the conclusion previously reached by Sismonda from an examination of Taninge, that "the plants of the carboniferous period were still flourishing while the seas were depositing the rocks of the nummulitic period."

The question involved in this controversy had more than a local interest, since it touched the very basis of paleontology, by pretending that in the Alps the laws of succession which elsewhere prevail were suspended, and that the same type of vegetation had continued unchanged from the paleozoic to the tertiary period. Already in 1841 Favre had brought forward the suggestion of Voltz, that these apparent anomalies might be explained by inversions of the strata, but this notion was rejected by de Mortillet and Murchison, as inadmissible for the section at Petit-Cœur. The recognition by Favre in 1861 of the true age and position of the cargneules and their associated rocks, however, threw a new light on the question, for it was shown that these triassic rocks were interposed at Petit-Cœur between the limestones holding belemnites and the schists with coal-plants. In 1861, the Geological Society of France held its extraordinary session at St. Jean in Maurienne, and there also the succession was made clearly evident, as follows: nummulitic, liassic, infra-liassic, triassic, and carboniferous; the last resting on crystalline schists.

Attempts had been made to sustain the supposed jurassic age of the so-called anthracitic formation, by maintaining that some at least of the coal-plants were jurassic forms; but Heer, who had long maintained the contrary, published in 1863 a farther study of the fossil flora of Switzerland and Savoy, in which he showed that of sixty species fourteen are peculiar to these regions, while forty-six belong to the carboniferous flora of Europe, and twenty-seven are common with that of North America. One species only has been indentified as of liassic age, viz: *Odontopteris cycadea* Brongn., and is found in a locality near jurassic belemnites, but associated with no other plant.

Both Lory and Pillet now admit with Favre that the supposed paleontological anomalies of this region have no existence, and that this anthracitic system includes carboniferous, jurassic and nummulitic strata inverted and folded upon themselves; nor is it without reason in this connection that Lory remarks upon "the illusions without number to which a purely stratigraphical study of the Alps may give rise." To this we may add the judgment of Dumont, in discussing the disturbed and inverted anthracitic system of the Ardennes, that for regions thus affected "we cannot establish the relative age of the rocks from their inclination or their superposition."

These conclusions were not, however, admitted by Sismonda, who in 1866 presented to the Royal Academy of Sciences of Turin an elaborate memoir on the anthracitic system of the Alps.* In this, while admitting at Petit-Cœur the existence of evidence of more or less contortion, rupture and over-riding (*enchevauchement*) of the strata, he still maintains that the anthracitic system of Maurienne and Tarentaise is one great continuous series of jurassic age, from the fundamental gneiss and protogine, upon which it immediately rests, to the upper member in which occur thick beds of anthracite with an abundant carboniferous flora; which he assigns, however, to the middle oolite (Oxfordian); the great mass of strata below being referred to the lias. He then particularly indicated the line of the great Mont Cenis tunnel, which, commencing in the upper anthracitic member, should pass downward through the quartzites and gypsums, thence through talcose schists and limestones, as far as Bardonnecchia. These schists and limestones, according to him, are in "a very advanced state of metamorphism," and include eruptive serpentines, with euphotide, steatite and other magnesian rocks.

Since the completion of the tunnel, Messrs. Sismonda and Elie de Beaumont have presented to the Academy of Sciences of Paris an extended report on the geological results obtained in this great work. It is accompanied by a description of 134 specimens of the rocks collected at intervals throughout the entire distance of the tunnel, which it will be remembered passes from near Modane in Savoy to Bardonecchia in Piedmont (about fifteen miles to the southwest of Mont Cenis), a distance of 12,220 meters. The direction of the tunnel is N. 14° W., and the dip of the strata throughout nearly uniform, N. 55° W. at an angle of about 50°. From this we deduce by calculation that the vertical thickness of the strata is equal to nearly 60 per cent of the distance traversed, or in round numbers about 7000 meters. Of this not less than 5831 meters, beginning at the southern extremity, are occupied by the lustrous more or less talcose schists with crystalline micaceous limestones, often cut by veins of quartz with chlorite and calcite. Above there are 515 meters in thickness of alternations of anhydrous sulphate of lime (karstenite) with talcose schist and crystalline limestone. The anhydrite enclosed lamellar talc in irregular nodules, with dolomite, crystallized quartz, sulphur, and masses of rock-salt. This was overlaid by 220 meters of quartzite, occasionally alternating with greenish talcose schists, and enclosing veins and masses of anhydrite. A considerable break occurs in the series of specimens above this, but for the distance of 1707 meters from the northern entrance to the tunnel, corresponding to a vertical thickness of 1024 meters, we have principally sand-

* Memoirs of the Acad., 2d series, xxiv, 333.

stones, conglomerates and argillites, occasionally with anthracite. The serpentines and euphotides which appear among the crystalline schists at Bramant, near the line of the tunnel, were not met with, nor was the underlying gneiss encountered. The work terminated at Bardonecchia among the crystalline limestones.

According to Sismonda and Elie de Beaumont, there is throughout this entire section no evidence of inversion, dislocation or repetition in the series of 7000 meters of strata, a conclusion which they support by very cogent arguments. Lory, on the contrary, while he agrees with the observers just mentioned in looking upon the crystalline strata as altered mesozoic, conceives them to include both trias and lias, and to be placed beneath the true carboniferous by a great inversion of the whole succession. This series of crystalline rocks is very conspicuous along the S. E. side of Mont Blanc, extending into the Valais, and is regarded by Lory as a peculiar modification of the trias and lias, so enormously thickened and so profoundly altered as to be very unlike these formations to the northwest of Mont Blanc. In this view he is followed by Favre (§ 666. § 753). The serpentines and related rocks of this series are by de Beaumont, Sismonda and Lory considered to be eruptive. The latter speaks of these as eruptions contemporaneous with the deposition of the strata, probably accompanied by emanations which effected the alteration of the sediments. According to Favre, they are clearly interstratified with the lustrous argillo-talcose schists, micaceous limestones and quartzites of the great series, and are by him placed in the trias. He has particularly described those of Mont Joret and those of the Val de Bruglié near the Petit St. Bernard, where they are immediately interstratified with greenish schists and associated with steatite, hornblendic and gneissic strata. The serpentines of Taninge in the Chablais, to the northwest of Mont Blanc, he also classes with these in the trias. The conclusions of Lory and Favre as to the geological age of these crystalline schists and limestones, appear to us untenable in the light of Sismonda's investigations. If we admit with the latter that the whole section of the tunnel represents an uninverted series, and with Favre that its uppermost and uncrystalline portion at Modane is truly of carboniferous age, it is clear that the great mass of crystalline schists which underlie the latter should correspond more or less completely to the pre-carboniferous crystalline strata to the northwest of Mont Blanc. Among these latter, in fact, as observed by Favre, there occur at Col Joli and Taninge crystalline limestones and talcose schists like those of Maurienne. According to this view, which harmonizes the conflicting opinions, and makes the crystalline schists and limestones of the southeast

pre-carboniferous, the anhydrites, with limestones, talcose slates and quartzites seen in the Mont Cenis tunnel, are not the equivalents of the gypsum and cargneule of the trias, but may correspond to the anhydrites, which with gypsum, dolomite, serpentine and chloritic slate, are met with in the primitive schists of Fahlun in Sweden.

The existence of great and perplexing inversions of strata in many parts of the Alps is well known. One of the most striking cases is that figured by Murchison in his remarkable paper on the geology of the Alps in 1848 (Quar. Jour. Geol. Soc., v, 246), as occurring at the pass of Martinsloch in the canton of Glarus, 8000 feet above the sea. Here nummulitic beds, dipping at a high angle S.S.E., are regularly overlaid by the succeeding sandstone (flysch); resting unconformably and in a nearly horizontal attitude upon the edges of which are 150 feet of hard jurassic limestone, overlaid in its turn by talcose and micaceous schists, which are by Escher regarded as similar to those which underlie these limestones in the valley below. This mass of flysch appears near by to dip beneath these limestones, which, in their turn, are regularly overlaid by neocomian and cretaceous strata. This remarkable superposition of secondary and older crystalline rocks to tertiary is explained by Murchison, in accordance with the suggestion of H. D. Rogers, as the probable result of fracture and displacement along an anticlinal. Many striking examples of inversion are described by Favre in the vicinity of Mont Blanc. The mountain of the Voirons, near Geneva, shows at its base tertiary overlaid by cretaceous rocks, upon which jurassic strata are superimposed. Similar phenomena are met with along the north side of the Alps from Geneva to Austria, and at various localities on the southern side, in Lombardy. This inversion, moreover, is by no means confined to secondary and tertiary strata. In the valley of Chamonix the secondary limestones dip at a high angle toward Mont Blanc, and plunge beneath its crystalline schists. Other examples of the superposition of crystalline schists to the fossiliferous sediments have been pointed out by Elie de Beaumont in the mountains of Oisans, and confirmed by Lory and Dausse, while similar cases have been recognized by Morlot and von Hauer in the eastern Alps, and by Ramond, de Boucheporn and others in the Pyrenees. All of these cases are by Favre regarded as examples of the same process of inversion already noticed in so many instances among the secondary and tertiary strata of the region. He proceeds to contrast these examples with that of the gneisses, chloritic and micaceous schists which in western Scotland, according to Murchison, overlie fossiliferous lower silurian beds, and are by him regarded as younger. This, upon the authority of Murchison,

Favre regards as a singular and anomalous fact. It should, however, be said that this view of Murchison is rejected by Nicoll, who explains the appearances as the result of dislocation and oversliding of older crystalline schists upon the newer fossiliferous beds, in which case the western Highlands will form no exception to the general law of similar appearances in the Alps and Pyrenees.*

The fact that the jurassic rocks in the valley of Chamonix pass beneath the crystalline schists of Mont Blanc was first noticed by de Saussure, and was afterwards observed by Bergmann and by Bertrand, who argued from this that the limestones were older than the gneiss. Bertrand's paper, as noticed by Favre, occurs in the *Jour. des Mines*, vii, 376 (1797–1798). Later, in 1824, we find Keferstein inquiring whether these overlying gneisses and protogines might not be altered flysch (that is, eocene tertiary), a view which he subsequently maintained. Similar views have found favor among later geologists: we find Murchison asserting the eocene age of certain Alpine gneisses, mica-schists and granites; while Lyell has suggested that the protogines, gneisses, etc., of the Alps may have resulted from the alteration both of secondary and tertiary strata. (Anniversary Address to the Geological Society, 1850). Studer has taught that the flysch of the Grisons has been changed into crystalline gneiss, while Rozet and Fournet, with Lory and Sismonda, have assigned to the Jurassic period the great system of gneiss, with talcose and micaceous schists, which make up Monts Cenis and Pelvoux, and much of the mountains on the frontier of Piedmont and in the Valais.

Hutton, as early as 1788, had taught that what he called the primary schists were sediments, the ruins of earlier rocks altered by heat, but it does not appear that he attempted to fix the relative age of any such altered rocks. In fact, the notion of geological epochs, based upon the study of fossils, was not as yet fully recognized. The suggestions of Bergmann and Bertrand that the crystalline rocks of the Alps are newer than the fossiliferous limestones which pass beneath them, seems to have been the first attempt to give to Hutton's view a definite and special application, and the inception of that theory with which we have since become familiar, viz: the conversion of mountain masses of paleozoic, mesozoic and even cenozoic sediments in the Alps and elsewhere into gneisses and other crystaline rocks. Numerous sections in the vicinity of Mont Blanc show the sedimentary strata in their normal attitude, resting unconformably upon the crystalline schists, while in some localities the whole succession from the carboniferous to the eocene,

* T. Sterry Hunt, Address before the American Association for the Advancement of Science, 1871, page 30.

both inclusive, is met with. In many parts, however, the carboniferous is wanting, and the trias forms the base of the column, while elsewhere the infra-liassic beds repose on the crystalline schists, and in the Bernese Alps no fossiliferous beds lower than the oolite are observed. These facts would appear to be connected with the movement of subsidence; which permitted the deposition of marine limestones above the carboniferous strata, and Favre has farther pointed out, in the vicinity of Dorenaz, a want of conformity between these and the succeeding formations.

To the carboniferous belongs the well-known conglomerate of Valorsine, which includes pebbles of gneiss, quartzite, talcose and mica-schist, and of quartz veins holding tourmaline. The paste, which is reddish, talcose and micaceous, seems identical with many of the pebbles, so that it is sometimes difficult to distinguish these from the matrix. A thin fibrous envelope often surrounds the pebbles (§ 521). Although the alternation of these beds with others holding plants shows them to be of carboniferous age, it is often, says Favre, difficult to fix the lower limit of this formation on account of the great resemblance between certain of the carboniferous sandstones and portions of the older crystalline schists, which, in cases where the former are destitute of pebbles, makes it impossible to distingish between the two. Necker, in like manner, asserted that it was impossible to draw a line of demarkation, and was hence led to assert a passage from the one to the other. The same close resemblance was noticed by de Saussure, and is testified to by de Mortillet and by Sismonda, who says of the feldspathic sandstone (*gres*) near St. Jean in Maurienne, that "unless we take care we run the risk of being deceived, and of confounding it with gneiss," while elsewhere similar rocks assume the aspect of granite from the predominance in them of feldspar. Hence it has happened that observers like Dolomieu and Bakewell placed the anthracites of the Alps in the mica-slate formation, and that Berger described as a "veined granite" the Aiguille des Posettes, which, according to Favre, consists of nearly vertical beds of carboniferous sediments. In illustration of this condition of things, Favre cites the observation of Boulanger, according to whom the triassic sandstones of the department of Allier are made up of quartz, feldspar and mica, so united as to give rise to a sandstone which would be taken for a primitive rock but for the occasional presence of a rolled pebble of granite.* The paste of this Valorsine conglomerate, which seems identical with certain of the enclosed pebbles, appears according to Favre to have undergone

* See Favre, *Terrains liassique et keuperien*, etc. (1859), pp. 78, 79, to which in his work he refers the reader for further explanation on this point.

a certain re-arrangement, so that the beds of these "pretendus schists crystallins" of the carboniferous are with difficulty distinguished from the "vrais schists crystallins" upon which they rest unconformably. I insist the more upon these details, because in the earlier notice of Favre's investigations I erroneously represented him as including in the carboniferous a great mass of the older crystalline schists.

In this connection we may cite the observation of Sedgwick, who cites similar cases of recomposed rocks in Scotland, "which it is not always possible to distinguish from the parent rock," and remarks that "a mechanical rock may appear highly crystalline because it is composed of crystalline parts derived from some pre-existing crystalline rock."* Emmons also has called attention to the existence of secondary or recomposed beds of talcose, chloritic and micaceous schists in the Taconic hills of western New England, which, according to him, have been confounded with the older parent rocks. It would hardly seem necessary to call attention to facts which are familiar to all field-geologists who have worked much among newer deposits in the vicinity of older crystalline rocks, were it not that their significance is so great in connection with Alpine geology.

This deceptive resemblance to the older crystalline rocks in the Alps, as might be supposed, is not confined to the carboniferous. Similar cases are noticed by Favre in the trias, while at the Cols du Bonhomme and des Fours are crystalline aggregates also noticed by Saussure as closely resembling the older crystalline rocks, which are shown by the fossils of inter-stratified beds to be of infra-liassic age. Studer, in opposition to Murchison, maintained that the apparently granitic layers in the flysch (eocene) near Interlaken are but the debris of an older crystalline rock, while the crystalline schists of the Bolghen mountain in the eastern Alps, supposed by Murchison to be in some way interposed in the flysch, are both by Studer and by Boué, regarded as merely masses of the older crystalline rocks in a tertiary conglomerate.†

In discussing the age of the "true crystalline schists" of the Alps, to make use of his expression already quoted, Favre, as we have seen, places them beneath the carboniferous, and in opposition to the suggestion of Murchison and the opinion of Gueymard, that they may be of cambrian and silurian age, concludes that we have no proof of the existence of representatives of these systems in the western Alps (§ 808). In this connection we may note with Favre the presence at Dienten in the Tyrol, of a silurian fauna, intercalated in beds of gray and green chloritic schists (§ 697 *b*). The gneiss of Mettenbach, near the Jungfrau, has afforded to Favre a pale green ophicalce

* Geol. Transactions (1835), iii, 479. † Ibid., iii, 334; Geol. Journ., v, 210.

resembling that of the laurentian, in which he has detected *Eozoon Canadense* (§ 697 *a*). Having thus declared his conviction of the great antiquity of the crystalline schists, whose ruins enter into the composition of the conglomerate of Valorsine, he proceeds to remark that "the part played in the Alps of Savoy by that mysterious force called metamorphism, to which the formation of the crystalline schists is often attributed, has been greatly exaggerated." He adds, "I have always been surprised to find in the Alps so few traces of this pretended action," and suggests that the question has been complicated by the resemblances already noted between the crystalline schists and the recomposed rocks of the coal measures (§ 697 *c*). In the same spirit he declared in 1859, that there are "scarcely any evidences of alteration after the Valorsine conglomerate;" in the paste of which he admits a crystalline re-arrangement by no means improbable.* It appears inconsistent with these expressions of opinion to find our author admitting with Lory the triassic and jurassic age of the great mass of lustrous schists and micaceous limestones which are overlaid by the carboniferous at Modane, and at various localities, as we have seen, include serpentines, steatites, etc. Our author feels this a difficulty, and speaks of these serpentines, unlike those of the Montanvert, the Aiguilles Rouges, etc., as belonging to non-crystalline formations, a character which can hardly be ascribed to them. If, however, Sismonda be correct in placing them below rocks which are, according to Favre, true coal measures, these serpentines and steatites, with their accompanying schists and limestones, are, as we have already shown, in the same horizon with the crystalline schists to the north of Mont Blanc.

The origin of the fan-like structure attributed to the Alps by nearly all observers since the time of de Saussure, and correctly represented in the sections published by Studer in 1851, and by Favre in 1859, is explained by the latter in accordance with the view put forward by Lory in 1860.† He supposes that the underlying crystalline rocks forced, by great lateral pressure, formed an elevated anticlinal arch, which, breaking on the crown, from the excess of curvature, shows the lowest rocks in the center of the rupture, flanked on either side by the overlying strata. These, in their upper part, are subjected to a comparatively feeble lateral pressure, while the deeper portions are forcibly compressed by the smaller folds on either side, from which results the fan-like or sheaf-like structure of the beds. The newer strata in the synclinals are by this process arranged in troughs, and are more or less overlaid by the older rocks. Such a

* *Terrains liassique et keuperien*, 77.

† Lory, description geologique du Dauphiné, p. 180

synclinal exists in the valley of Chamonix, between the two ruptured and eroded anticlinals represented by Mont Blanc and the Brevent. In illustration of this structure Favre has given a grand section commencing to the northwest in the mountain known as Les Fiz, which, overlooking the Col d'Anterne, rises to a height of 3180 meters and displays all the Alpine formations from the sandstones of Taviglionaz, overlying the nummulitic beds, down to the carboniferous, which is seen resting on the crystalline schists. These appear in the height of Pormenaz and in the Brevent, at the northwest base of which the carboniferous rocks are arranged in a sharp fold dipping beneath the crystalline strata. The latter to the northeast rise in the Aiguilles Rouges, which are steep hills of vertical beds including hornblendic, chloritic and talcose rocks, with petrosilex, eclogite and serpentine. The highest of the Aiguilles rises 2944 meters above the sea, and consequently 1892 meters above the valley of Chamonix. This summit, which was visited by Favre, was found to be capped by horizontal strata, consisting at the top of about thirty-seven meters of jurassic beds, with belemnites and ammonites, underlaid by infra-liassic strata with cargneules, sandstones and schists, the whole resting upon vertical strata of unctuous mica-schists, which enclosed a bed of saccharoidal limestone. From thence we pass over the valley of Chamonix, which holds enfolded in crystalline schists, triassic and jurassic strata, and over the summit of Mont Blanc to find the same folding repeated between the base of the latter and the protogines of Mont Chetif. The fan-like structure attributed to this last is questioned by Lory, according to whom the strata of this mountain dip uniformly to the southeast, and are overlaid by the great mass of crystalline talcose schists and micaceous limestones assigned by him to the trias, but apparently, as we have endeavored to show, a portion of the pre-carboniferous crystalline schists. These rocks are well displayed farther on in the mountain of Cramont, and are regarded by Favre as identical with those of Mont Cenis.* Lory conceives that the attitude of the rocks of Mont Chetif to the jurassic strata in the trough at the southeast base of Mont Blanc is due to a great fault with an uplift, which has brought these older rocks to overlie the jurassic beds.

With the facts before us, we can with Favre trace the history of Mont Blanc from the time when over a partially submerged region of gneiss and crystalline schists the carboniferous strata with their beds of coal and their plant-remains were being deposited; many of the strata being made up from the partially disintegrated crystalline schists and scarcely distinguishable from them. After some disturbance the secondary formations were

* See in this connection Hebert, Bull. Soc. Geol. de Fr., 2, xxv, 356.

laid down unconformably alike over the carboniferous and the older strata, followed by the nummulitic beds and their overlying sandstones, the whole, from the base of the trias, having in this region an aggregate thickness of about 1250 meters. Subseqently to this occurred the great movements which threw into folds all these strata, enclosing, as in the Tarentaise, the nummulites with jurassic and carboniferous fossils among the folds of the crystalline schists. This was followed by great denudation, which removed from the broken anticlinals the secondary rocks, leaving however, in the horizontal jurassic beds which still cap the Arguilles Rouges, an evidence of the former spread of these formations, which once extended over what is now the summit of Mont Blanc. It is worthy of note, that the highest portions of this latter do not exhibit the underlying gneiss, but are capped by crystalline schists, which may be supposed to rest upon it, as do the secondary strata upon the schists of the Aiguilles Rouges. These elevated points are evidences of the enormous erosion in this region, the results of which have contributed to build up in the lower regions of the Alps and in the Jura, the great masses of miocene sediment known as the molasse; a formation partly marine and partly lacustrine, which attain in some parts a thickness of more than 2,000 meters. This period was followed by other movements, which have raised the beds of molasse to a vertical attitude and in some cases inverted them, so that they appear dipping beneath the nummulitic formation. It is worthy of note that the molasse near Geneva includes in its upper part a lacustrine limestone, followed by marls with gypsum, and by lignites.

That the nature of the fan-like structure of the Alps is correctly represented in the sections of Studer, Lory and Favre, can, we think, no longer admit of doubt. Another explanation was, however, possible; the dipping of the beds on either side toward the center of the mass might indicate synclinal mountains, lying between two eroded anticlinals. Such a mountain-structure appears not to be uncommon in regions where the undulations are moderate; and is, according to Lesley, frequent in the anthracite region of Pennsylvania. Snowdon in Wales, according to Ramsay, and Ben Nevis and Ben Lawers in the Scottish Highlands (Murchison), are also examples of this structure, the summits of all of these being composed of newer strata, beneath which, on either side, dip the older formations. When, therefore, geologists of authority from Bertrand and Keferstein to Murchison and Lyell maintained that the crystalline rocks of Mont Blanc were newer than the limestones of the valleys on either side, and even declared them to be altered sediments of the tertiary period, it was difficult to regard Mont Blanc as any thing else than a synclinal moun-

tain similar in general structure and origin to those just mentioned. Hence it was that in 1860 (this Journal, II, xxix, 118) I remarked "the weight of evidence now tends to show that the crystalline nucleus of the Alps, so far from being an extruded mass of so-called primitive rock, is really an altered sedimentary deposit more recent than many of the fossiliferous strata upon their flanks, so that the Alps, as a whole, have a general synclinal structure." This view of the recent age of the crystalline rocks of this region, supported though it has been by the authority of great names, must now, we conceive, be abandoned, and their great antiquity, as maintained by the learned professor of Geneva, admitted. It, however, remains true that the extrusion and laying bare of these ancient crystalline rocks is, as we have seen, an event geologically very recent.

It would greatly exceed our present limits to notice our author's learned discussion of the superficial geology, including the glacial phenomena, of the Alpine region, to which the present work is devoted. His views upon some of the most keenly controverted questions with regard to glacial action will be found set forth in his letter to Sir R. I. Murchison on the Origin of Alpine Lakes and Valleys, which appeared in the L., E. and D. Philos. Magazine, for March, 1865.

This beautiful work of Prof. Favre is accompanied by an atlas of thirty two folio plates, embracing maps, sections, views and figures of organic remains, which elucidate the text in a very complete manner. It is a magnificent monument to the industry, acumen and scientific zeal of one who for a quarter of a century, has devoted his time and his fortune to the pursuit of science, and has worthily completed the task which his illustrious countryman de Saussure commenced.

ART. II.—*Supplementary Note on the Genus Lichenocrinus;* by F. B. MEEK.

SINCE writing the remarks published in the October number of this Journal (p. 299), I have received from Mr. Dyer a very complete suit of specimens belonging to the two known species of this curious type. One of these specimens seems almost to demonstrate that the long, slender, column-like appendage, mentioned in the descriptions, cannot correspond to the ventral tube or so-called proboscis of crinoids. This specimen is a small individual of *L. Dyeri*, only measuring 0·22 inch in diameter across the disc; yet its column-like appendage measures near

2·80 inches in length, and tapers very gradually and regularly from a diameter of 0·03 inch near the disc, to that of scarcely 0·01 inch near the free end, where it actually appears to taper to a mucronate point. Of course the canal, within so attenuated an appendage, must be extremely minute, and could scarcely have performed the same functions as that of the ventral tube of a crinoid, even if open at the free end, which is at least exceedingly improbable.

The extreme tenuity of the free end of this appendage (which I had already mentioned as an objection to viewing it as a ventral tube), appears to be almost, if not quite, as strong an objection to the suggestion that possibly the disc might have been a root, with the real body attached at the other extremity of the long appendage; since it is scarcely possible that a body could have been supported at the free end of such an extremely slender, hair-like organ as that of the specimen under consideration.

This and some of the other specimens also show that, at least in the species *Dyeri*, this long appendage, although apparently equally divided longitudinally by five sutures along its entire length, does not always have the pieces of which it is composed, distinctly alternating and interlocking along these sutures, excepting near the disc. On the contrary, these pieces sometimes become gradually less and less alternately arranged, until they appear to the eye, as examined by the aid of a glass, to abut against each other, so as to form regular joints, like those of a minute column composed of little rings or discs. In the specimen under consideration there appears, at a first glance, to be two of these long appendages issuing from one disc, or body, but a closer inspection shows that there are two of the discs growing or crushed, one against, or partly upon the other.

The inquiry has been suggested, whether these may not have been free crinoids, with the power of attaching and detaching themselves at will, by the flat side opposite the long appendage? Among the objections, however, that present themselves to this view, may be mentioned the fact, that the most careful examinations under the very best magnifiers, of both the inner and outer surfaces of this flat side, by which the disc is usually found attached, fail to detect even the most minute openings; and as there are no traces of arms or pinnulæ, it is difficult to understand by what means the animal could thus have attached and detached itself, or have sought, and adjusted itself to, a suitable station, when once detached. In addition to this, they are sometimes found growing upon uneven surfaces, and closely conforming to the inequalities of the same, even to lines and furrows on the surface of a shell; while the rigid radiating

laminæ of the interior would seem to preclude the possibility of such an adjustment by flexibility.*

It is perhaps scarcely necessary to add, that the irregular arrangement of the plates composing the disc of this type, without any tendency to arrange themselves into radial and interradial series, together with its general habit of growth, show that it belongs to the *Cystoidea*, and not to the typical group of *Crinoidea*. Its want of arms and pinnulæ also approximate it to the *Cystoidea*, in which the arms are generally in a more or less rudimentary condition, or the former, in some cases, even entirely wanting. In its apparent entire absence of both arms and pinnulæ, and especially in its want of visible openings, and the possession of a system of internal radiating laminæ, it is entirely peculiar, and unlike any other known type, either of the typical *Crinoidea* or *Cystoidea*. How the respiratory, reproductive, and nutritive functions, of such a being as it appears to be, could have been performed, remains a mystery, and hence it is evident that something yet remains to be learned in regard to its structure.

Of course, such a form cannot be properly ranged in any of the recognized families of the typical *Crinoidea* or of the *Cystoidea*, but should be regarded as the type of a new family of the latter, under the name *Lichenocrinidæ*.

ART. III.—*A Cretaceous Basin in the Sauk Valley, Minnesota;* by J. H. KLOOS.

ASCENDING the Mississippi from Prairie du Chien to St. Paul, we pass between the lowest deposits of the Silurian formation, as it is developed in the Northwest. As far as the mouth of the St. Croix river, the shores of the mighty stream consist of the lower or Potsdam sandstone, capped by the lower magnesian limestone, generally considered to be the equivalent of the Calciferous sandstone of New York. From the St. Croix river to Red Rock, the castellated bluffs consist entirely of magnesian limestone, and give a peculiar character to the scenery; the sandstone, participating in the gradual and hardly perceptible northern dip of the strata, having disappeared under the level of the water. At Red Rock, St. Peters sandstone and

* One specimen, now before me, from Mr. Dyer's collection, is seen lying in the matrix in such a manner as to expose the detached under side of the disc; while one of its edges is curved and folded upon itself. As none of the plates, however, is broken or displaced, nor any of the sutures between them gaping along the folded edge, I cannot believe this folding due to flexibility, but that some peculiarity of its station caused this individual to *grow* in this way.

Trenton limestone take the place of Potsdam and Calciferous, continuing to St. Paul and St. Anthony.

These are the last exposures of Paleozoic strata on the Mississippi; they disappear above the Falls of St. Anthony under an extensive covering of drift. Nothing but clay, gravel, sand and boulders are exposed in the low banks of the river, until near the city of St. Cloud, where we reach a belt of granitic, syenitic and dioritic rocks, rising in long belts of low hills over the surrounding prairie. Here and farther above, the river takes its way in a series of rapids over the ledges of the crystalline rocks. These extend over 35 miles, the intervals between them being filled and levelled with drift. On the north, at the village of Little Falls, they are succeeded by mica and quartzite slates, dipping to the northwest under angles varying from 65° to 72°.

This belt is an upheaval of Azoic rocks, crossing the State of Minnesota over its entire length from north to south, and corresponding probably to the lower part of the Laurentian system of Canada. It is exposed on the Rainy River and the lakes in the extreme northern part of the State, as well as on the St. Louis, Rum, Mississippi and St. Peter rivers, though over its greatest extension concealed by recent deposits. Gneissoid rocks, prevalent in the northern portion of this belt, are not found on the Mississippi, where, besides syenitic granites, the so-called anorthosite rocks form a characteristic feature of the formation.* I have not yet succeeded in finding the crystalline limestones of the Canadian Laurentian, though at several places west of the Mississippi I have met with large limestone boulders, which I refer to this period. At St. Cloud, Sauk Rapids and Watab on the Mississippi, the rocks of the Laurentian ridges are quarried and are commencing to be used extensively for fronts of large blocks and government buildings at St. Paul, Chicago and even in cities lower down the Mississippi Valley. Some of the syenitic and dioritic varieties form a splendid material for ornamental work and monuments.

Leaving the Mississippi at St. Cloud and going westward up the Sauk Valley, we cross the belt of Laurentian rocks at right angles, and remain among the low granitic hills for 25 miles. There is no continuous ridge or uplift; at several places we find ledges of granite, syenite, granitoporphyry, hypersthenite and diorite, either exposed at the water's edge or cropping out on the prairie. The river, however, has not cut deep enough into the solid rock to show the continuance of the ledges, and the glaciers and icebergs of the erratic period have swept over

* Sauk Centre, 40 miles west of the Mississippi, is the only place where I found an outcrop of granite to have a somewhat gneissoid structure. It is here associated with a diabase.

the whole country, levelling the surface, and leaving only the highest uplifts of the older formation exposed to view.

The first rock we met with after crossing the St. Cloud prairie, is a red feldspathic granite, protruding from the drift at the point where the Rockville road reaches the Sauk. Like all the granitic and syenitic rocks which I observed in this part of the State, it contains, together with the common feldspar or orthoclase, an albite or other oligoclastic feldspar with well defined striated cleavage planes.

Eight miles from St. Cloud on the bank of the river, I saw the first boulder of an exceedingly course granite, different from any rock exposed on the Mississippi. These boulders are frequent on the prairie between Rockville and Cold Spring, on which they form a marked feature by their large size and peculiar shape.

The exposed part of one is 12 feet long, 10 feet wide and 8½ feet high. Another one measured 24 by 14 by 5 feet. All planes and edges of these boulders are rounded, except one plane corresponding with a system of fissures, well defined on every one of them. At the largest of all, the corresponding fragment was still visible, though detached from the principal mass, and a space of four feet now intervening, in which brush and grass had taken root.

These huge masses of granite have not been transported far. At Rockville the same rock forms a distinct ledge, running from the range of hills toward the river. The cliffs of the outrunning ledge show the same outlines as the boulders.

Near Cold Spring we come to another exposure of granite, the intervening four miles forming quite a broken prairie, traversed by erratic hills covered with timber. Here the river takes a leap over the ledge of rock and forms a good waterpower, which is used for manufacturing purposes. A porphyritic granite, not distinguishable from the same kind of rock on the east side of the Mississippi, rises in beautiful cliffs above the water, and crossing these we reach another extensive exposure of the above described coarse granite. Both cross the Sauk, and the line between them is marked by a depression, in which a bridge has been swung across; they strike very nearly east and west. From here to Richmond the coarse granite is altogether the prevalent rock. Several ridges are distinguishable, croping out on the slightly rolling table land, and their presence is marked on the surface by a coarse grit of feldspar and quartz. They are seemingly in range with the line of hills at Cold Spring, bearing generally east and west.

Richmond itself is built on a high level prairie, entirely covered with farms, but having rather a sandy soil. To the

right the view is bounded by a range of timbered hills, rising abruptly above the prairie and extending in a westerly direction. Near the river and to the southeast of the village, I found quite a variety of anorthosite rocks, containing a triclinic feldspar in fine crystals, with some variety of pyroxene. The texture of these rocks is generally fine-grained; some are somewhat coarser and porphyritic. They are all of dark color, and occur in parallel veins in the granite.

These kinds of crystalline rocks have a wide range in the Laurentian belt of Minnesota, and present many points of interest. I hope soon to have an opportunity to compare them with similar rocks, which in Germany have been the subject of elaborate chemical and mineralogical investigations, and expect to come to very interesting results. As yet I have had no occasion to determine the nature of the feldspar and the species of pyroxene, though I expect to find labradorite, anorthite and hyperite, with hornblende, mica and perhaps protobastite the principal constituents.

The Sauk river cuts 30 feet deep into the prairie at Richmond. In its banks deposits are exposed, differing entirely from any which are found in the valley below this point. They consist principally of plastic clays, of which the prevalent color is a dark blue; still there are streaks of a brilliant white running through these, and some containing more iron are yellowish. At one place we see them rest on a conglomerate of decomposed granite of a white and light-reddish color. At another point on the river, a thin seam of iron ore, impure peroxide of iron, runs through the strata, and a few feet above the conglomerate a thin seam of an impure lignite can be seen. All these strata lie apparently horizontal. They belong to an older period than the Drift formation, and, as I will show further on, are part of the eastern extension of a Cretaceous basin in the old crystalline rocks, which extend south and west, and is probably connected with the Cretaceous basin of Dakota, so extensively developed on the Missouri river.

The banks of the Sauk river do not throw much light upon the age of the strata, the plastic clay having only furnished me the small tooth of a Carcharodon. The shaft and borings, which have lately been sunk by parties expecting to find coal beds of economical importance, have, however, brought to light shales and slates containing fossils, from which we may conclude with absolute certainty that the formation is an equivalent of the Benton group or No. 2 of the northwestern series of Cretaceous, as established by Meek and Hayden. Not only are the remains of fossil shells and of fishes the same as those found in the Benton group, but the development and nature of the deposits are entirely similar. In both localities they con-

sist predominently of plastic clays, with some shale, slate, impure lignite and iron ore. The plasticity of those heavy claybeds is so peculiar to the Benton group, that it can easily be distinguished from the sandy and marly deposits, as well as from the marly limestones composing the succeeding number of the Cretaceous.

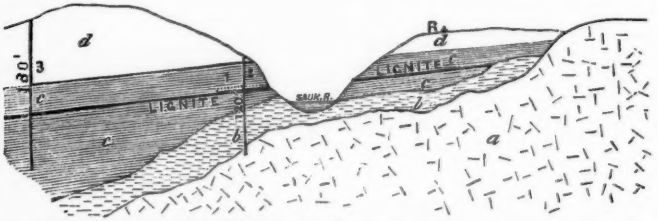
As the explorations in search of coal, above referred to, have been made by persons entirely ignorant of geology, I received very imperfect data in regard to the different strata through which the borings were made. A farmer having discovered the seam of lignite in the bank of the river, commenced several years ago digging a drift. After having advanced 60 feet, he had to abandon his imperfect mining operation, the river rising suddenly after a heavy rainfall and filling his drift. He afterwards found coal three miles north of Richmond among the timbered hills, and investigated here through three or four little shafts. Not being protected in any shape, the work had also to be abandoned on account of the water rushing in, after he had dug a few feet. Nothing was done further until recently, when some parties from St. Cloud leased all the land in and around Richmond for the purpose of exploring the supposed coal fields. They commenced sinking shafts and borings near the spot where the short drift was driven into the river bank six years ago. This old drift opens ¼ mile northwest of Richmond on the west side of the river a few feet over the conglomerate mentioned above, and in the blue clay. Of the coal or lignite formerly found here, very little can now be seen. The small fragments which I found were very impure, and consisted mostly of bituminous shale. The man who performed the work in 1865, told me that he had followed a seam of lignite four inches thick, which kept increasing in thickness, but remained impure and was considerably mixed with shale. The lignite seems to dip towards the interior of a high hill of drift, which rises abruptly from the river in a southwestern direction. He estimated the dip for the whole length of his 60 feet drift to be four feet, which would indicate quite an inclined condition of the strata, as would naturally be the case at the extreme end of a basin, near the old shore of the Cretaceous sea.

In a southwestern direction from the opening of the drift, almost on the top of the hill, a shaft was sunk and continued by boring for 180 feet. The information relative to the traversed strata, which I received here, was entirely unreliable, and showed the greatest ignorance on the part of the man who had charge of the work. The material lately brought to the surface, and that piled up around the shaft, consisted of blue, white and yellowish plastic clays, with few boulders and some shale. There must have been a heavy covering of drift and gravel to

be traversed before the clay was reached, the opening of the shaft lying considerably above the plateau or level prairie on which Richmond is built, but I have no means of ascertaining the thickness of the different strata. This boring has since been abandoned at 180 feet, when no more coal had been encountered than what the old drift had brought to light.

Nearer the river another shaft and boring had been sunk. Here I found several fragments of shale containing scales of cycloid-fishes, which had been met with near the surface. The boring was afterwards continued to a depth of 112 feet, when the borer struck a hard rock, which proved to be granite. It was drilled for eight feet, and the fragments brought to light by the pump consist of feldspar, quartz and pyrites, such as are found in varieties of pegmatite or graphic granite, which I also found at the nearest outcropping ridges of the crystalline rocks.

The profile of the strata on a line running nearly northeast and southwest, going through the different points where investigations have been made, would show as in the annexed wood-cut:



1, drift 60′ long; 2, 3, shafts 112′ and 180′ deep. *a*, *a*, granite; *b*, *b*, kaolin; *c*, *c*, plastic clays and shales of the Benton group Cretaceous; *d*, *d*, drift.

Having heard that fossils had been found in digging wells on some farms situated on the timbered hills south of Richmond, I extended my investigations in that direction. There are no further exposures on the surface, which is exceedingly broken but entirely shaped out in deposits of a Post-tertiary age. Two miles south of Richmond I came to a farm, where a well had excited the wonder and curiosity of the neighbors. This well was 30 feet deep, from where a hole had been sunk a further distance of 10 feet. At a depth of eight feet the blue clay (*c. c.* of the profile) was struck, passing into shale near the bottom of the well and containing a number of fossils. The water of this well was strongly saturated with sulphureted hydrogen, but lost the taste and smell almost entirely after having been exposed for some time to the atmosphere. When at the place, I was not able to obtain more than fragments of the shells, which I had, however, no difficulty in recognizing as belonging to the genus *Inoceramus*. Afterwards the well was dug down further,

and I obtained some pretty fair casts and parts of the shells, which will be mentioned farther on, in a note by Mr. Meek.

When last heard from, the well had a depth of 55 feet, and a boring had been sunk to a further depth of 25 feet. The following section is a nearly accurate description of the strata traversed:

8 feet gravel and sand.
30 " dark blue laminated clay. Fragments of *Inoceramus problematicus* and crystals of gypsum.
8 " clay and hard sandy shale of a light blue color, with pyrites, mica and fish scales. Cast of *Inoceramus*. At 40 feet a thin seam of lignite.
10 " same clay with more shale 3 to 4 inches thick. Shells of *Inoceramus* and *Scaphites* in the shale having retained their original color and pearly luster. In 50 feet another seam of lignite.
15 " dark blue clay without shale; color darker than the clay above and turning almost black. At 65 feet a hard shale of a grayish black color had to be drilled through.
10 " clay with thin layers and seams of pyrites.

As this boring is commenced at an elevation of 30 feet above the level of the base, communicating with the Sauk river, we are on nearly the same level with the prairie at Richmond. In a slough, having an outlet to the lake, at the foot of the hills, the blue clay lies near the surface.

The locality which furnished me the fossils is two miles south of Richmond, in continuation of the line of our profile. The formation here has probably a thickness of several hundred feet.

The following note in regard to the fossils already mentioned, is from Mr. F. B. Meek, to whom they were submitted:

MR. KLOOS—Dear Sir: The specimens sent by you from near Richmond, Minnesota, were duly received. They consist of casts of *Inoceramus problematicus*, impressions apparently of *Ammonites percarinatus*, scales of fishes and a small shark tooth allied to *Corax* or *Galeus*. Among the drawings also sent by you, there is one of the inner volutions of *Scaphites larviformis*, or some nearly allied form.

From these fossils, and the lithological character of the bed in which they were found, there can be no reasonable doubt, that it belongs to the Cretaceous system, as well as to the Benton group of the Cretaceous series as developed in the upper Missouri country. As you have suggested, the locality at which these specimens were collected, cannot be far from the eastern limits of the great Cretaceous basin that occupies so much of the country along the Upper Missouri; and it is very desirable that the eastern boundary of this group of rocks should be traced out as accurately as possible,

through Minnesota. Owing to the heavy deposits of Drift there, however, this will be a difficult task, and can only be done by careful observations of all that is revealed by deep wells and other excavations. Consequently it is important that all the facts, brought to light in this way, should be carefully noted and published.

The amount of labor and money squandered by the parties who sunk the shafts and borings, and excavated the drifts mentioned by you, with the vain hope of finding true coal there, is another example of the folly of undertaking such enterprises without consulting some competent geologist. A sight of any one of the fossils already mentioned, and a knowledge of the fact that the beds in which they occur lie down nearly or quite upon granite, would, as you are well aware, enable any geologist to decide, *at once*, that true coal will never be found there. And from all that is now known in regard to the Cretaceous series of the Upper Missouri, it is also exceedingly improbable that even lignite of sufficient purity, and in proper quantities to be of much practical value, will ever be discovered in the region mentioned.

Very truly yours, F. B. MEEK.

Washington City, D. C., 1871.

Future investigations must develop the extent of this Cretaceous basin. At only one more locality have I succeeded so far in finding the same clay. This is on the north shore of White Bear Lake, in Pope county, near Glenwood, a village situated forty-two miles west of Richmond, and seventy-five miles west of the Mississippi. Here it makes its appearance under a cover of drift, which must be at least 200 feet thick and in which all of the beautiful landscape has been shaped, which has made Glenwood a favorite resort for tourists and pleasure-seekers. This locality is the only positive proof I have, therefore, that these strata extend over the western portion of the State, though I have not the least doubt that this is the case, and that the Cretaceous clays underlie the Red River flats of Quarternary origin.

In the southern part of the State, on the Cottonwood river, Professor James Hall has traced the beds of lignite with friable sandstones and arenaceous clays, containing leaves of dicotyledonous trees, known to be Cretaceous.* This basin, lying in the red quartzites of the Huronian formation, is probably an equivalent of the Dakota group on the Missouri. Fragments of baculites have been found in Noble county in the extreme southern part of the State, in the clay beds several feet under the surface. These fragments are now in the possession of Dr. Sweenye, President of the Academy of Natural Science at St. Paul, and seem to indicate the occurrence of the highest beds of the Cretaceous series in Minnesota.

* Notes upon the Geology of some portions of Minnesota, from St. Paul to the western part of the State (Trans. American Phil. Soc., vol. xiii, pp. 329).

Though all these localities are fully 250 miles east of the Missouri, there is nothing in the configuration of western Minnesota and eastern Dakota to forbid the thought of a connection of the Cretaceous strata from the Mississippi to the Missouri. There are no uplifts of older rocks in any of the hills and watersheds, which are met with between the two rivers in this latitude. Both the Leaf Hills in Minnesota, and the Coteaux in Dakota, are huge accumulations of drift. I have crossed the Leaf Hills in several places for the purpose of finding a line for a railroad to the British possessions, and have nowhere met with any rock in place. These hills are from six to ten miles wide, and consist of parallel ranges, extending nearly northeast and southwest. The slopes are everywhere covered with boulders and gravel, and the whole gives decidedly the impression of being a glacial formation, in which the long lines of parallel hills are old side-moraines, and the lower cross-ridges the former end-moraines.

I have not yet visited the Coteaux, but all information received from voyageurs and surveyors, having crossed the country between the Red River and the Missouri, tends to show that at least between the parallels of 45° and 47° they do not contain any upheavals, and that they are in every respect similar to the Leaf Hills.

Both ranges consequently have a later origin than the Cretaceous formation, and did not exist when the country was submerged by the Cretaceous sea. They do not necessitate a separation of the Cretaceous series in different basins. The Benton and subsequent groups being several hundred feet thick and of a decidedly marine origin, it is more likely that one large sea has covered the interior of the American continent instead of shoal lakes, which would have given origin to lacustrine deposits.

On the maps showing the extent of the Missouri Cretaceous, the eastern limits of the formation are shown as disappearing under a heavy covering of drift, and as yet nothing was known as to the position of the eastern rim of this extensive basin.

The Sauk Valley and prairie at Richmond form the most eastern limits of the Cretaceous strata, and it is probable that they are also situated near the old northeastern shore of the sea, in which they have been deposited. The blue clay and seams of lignite have been traced three miles to the north of the village. At the present time, all signs of the presence of older deposits under the accumulation of drift have almost entirely been obliterated, and it is impossible to get a correct idea of the position of the strata. The State Geologist, Henry Eames, visited this locality in 1866, when three little shafts were sunk by the discoverer of the lignite. He describes the strata to be inclined under an angle of 65°. There seems to have been en-

countered three separate seams of lignite in short distance under each other, and separated by clay and shale. Eames assumes that they are fragments of the same bed having been brought into its present position by a great slide.*

Whatever may be the position of the strata in this locality, there can be no doubt that the granitic ledges of the Laurentian belt crop out in the vicinity, and that they are covered by heavy timber. At Sauk Center, a village situated on the Sauk river, forty miles west of the Mississippi, I found granite and diabase in parallel ledges, cropping out on the prairie. This place is only a few miles north of a line drawn from Richmond to Glenwood. The present bed and valley of the Sauk river can therefore safely be taken as nearly defining the northern limits of the basin.

Further researches, to define the eastern and northern boundaries of the great Cretaceous sea bordering on the Rocky Mountains, will be of great interest for the geology of the interior of the American continent. The future will probably show that Cretaceous strata are spread over a great area in Minnesota, resting on Laurentian, Huronian and Silurian rocks, and covered partly by Tertiary deposits.

St. Paul, Minnesota, October, 1871.

Art. IV.—*On a New Species of Fossil from the Lower Silurian;* by U. P. James.

Cyrtolites costatus. Body of shell nearly cylindrical; volutions about three, barely contiguous, enlarging rapidly; aperture nearly circular, slightly expanded; surface marked by strong longitudinal costæ, smaller costæ coming in at different stages of growth, so that as they approach the aperture every third one is stronger and more elevated than the two between; strong transverse ribs or lines of growth at irregular intervals, with fine striæ between; umbilicus large and deep; diameter of disk eight lines, but in this respect individuals of different ages must vary, as well as in the number intermediate costæ.

This species may be readily determined by the strong longitudinal costæ and deep umbilicus.

Position and locality.—Lower Silurian, Warren county, Ohio, about the middle of the Cincinnati group. Found September, 1871. My cabinet.

* H. Eames, Geological Reconnoissance of the Northern, Middle and other Counties of Minnesota, in 1866, St. Paul, 1867.

ART. V.—*Glacial Action on Mount Katahdin;* by JOHN DE LASKI, Carver's Harbor, Maine.

ON the twenty-first of September last, in company with Mr. George E. Bird of Portland, a graduate of Harvard College, and a guide from Sherman, the next town south of Pattern, I ascended Mount Katahdin, the highest land in Maine, on the south side by way of one of the "slides." The weather was fine, with few clouds in the sky till late in the afternoon. This slide I take to be the same by which Prof. Charles H. Hitchcock and party ascended to the top of Katahdin ten years ago.* On this route, after crossing Avalanche Brook at the base of the mountain—the stream of which is fed by springs up toward the top of Katahdin—we found fossiliferous rocks at various heights in our path. Boulders of this character were met with well up toward the "Horseback" ride, and I judged the highest place of their occurrence to be seven hundred feet below the "Chimney" top. This is the highest peak in the region except Pomola, the apex of Katahdin, which according to Dr. Young, with whom I visited the mountain twenty-four years ago, is five thousand three hundred feet above the sea, and according to Prof. Hitchcock, eighty-five feet higher.† I do not think the "Chimney" top is more than three hundred feet below the top of Pomola, and probably two hundred would be nearer the truth; and if this is added to the seven hundred feet, and the amount taken from the height, we have four thousand three hundred and eighty-five feet for the height of the fossils above the sea; and if we call the foot of the slide three thousand feet above the ocean, we have nearly fourteen hundred feet above the foot of the slide for the locality of the upper fossils.

In connection with these Devonian fossils—all of them impressions of shells of Oriskany beds—we found small boulders of micaceous sandstone and arenaceous schist, and a specimen of epidote; and Mr. Bird found a specimen of flint, undistinguishable from chalk flint, higher than the localities of the foreign boulders found by me. I should judge his specimen to have lain five or six hundred feet higher than the boulders containing fossils. The mass of flint would weigh a pound or more, and was water-worn.

Now the question presents itself, how came these erratic boulders—fossiliferous and non-fossiliferous— on the south side of Katahdin? The entire mountain so far as I saw it—and I have also been up it by the way of the north side to the top, and down that of its eastern side—is syenite, like that of the "granite" of Vinalhaven, but generally of a coarser texture.

* Report of Scientific Survey of Maine for 1861, p. 397 † Ib., p., 308.

I am not able to agree with Prof. Hitchcock in regard to the manner of the deposit of these fossiliferous boulders. He suggested that "they came round the west side of the mountain."* If we admit the iceberg theory—for the last few years considered nearly extinct, and which Mr. Hitchcock advocated at the time of writing the sentence above, ten years ago—there is the smallest possibility that those Devonian fossils could have been transported by icebergs—or floe-ice—from their native beds just north of Katahdin from fifteen to thirty five miles, and dropped on the south side of the mountain. The Oriskany beds are three thousand feet lower than the locality where the fossils were found on the shoulders of Katahdin.

The southwestern and southeastern sides of Katahdin bear evidence of glacial erosion—that is, these slopes have the uniform cut-off appearance, that all our northern hills have, even down to the ledges of our fields. At the base of the slide by which we ascended, we took the direction and found that all the higher parts of the mountain bore northwest, north, and northeast; and it is therefore evident that a glacial sheet slowly moving over this part of Maine, and not investing the higher parts of Katahdin, could not have had a portion of its mass so deflected—from the west, or east—as to crowd its boulders into this southern locality; for the sheering of the glacier must have been at right angles to its normal path. The glacial stream would have poured its boulders into this quiet and depressed basin of ice on the southern side of Katahdin, at an angle probably never more than forty-five degrees. And theory would give a much greater height to the crests of the deflecting ice-ridges or waves of the glacier, than the height of the locality of those fossils found by Prof. Hitchcock and myself. Furthermore, could these fossils, originally *in situ* not far distant from Katahdin, on low-lying lands, have worked themselves, during their short journey, from the bottom of a glacier to a position fourteen hundred feet higher into the body of the ice-cap? Though large boulders do sometimes appear on the surface of a valley-glacier (having obtained this position from some inferior locality owing to the complex pressure of the moving ice-mass), we may safely doubt, I think, whether small boulders weighing from half a pound to two or three pounds, would be likely to be materially displaced as regards their original position in the great glacier, during a progress of not many miles, and that up an inclined plain.

Nor is there much probability that those fossils were originally deposited in the localities where we find them. The "slide" is everywhere a plain of yielding sand and gravel, whose material has a constant tendency to descend.

* Report of Scientific Survey for 1861, p. 395.

Along the "Horseback" lie boulders so perched upon one another that we are sure they were not piled up by any frosts to which the mountain has been exposed in modern times; in fact, no frost agency could have put them in their present position. The ridge is narrow, and drops at an angle not differing much from forty-five degrees. We can safely presume that snow never accumulates on this ridge to any considerable depth. This locality is the very focus of winds at all seasons of the year, and especially during the winter months. What snow falls there is probably transformed into ice, and would not have much downward movement over the narrow ridge as avalanches. These boulders I consider to have been loosened by the glacier, which invested and overtopped them, though some of them may be erratic. The evidences in regard to the boulders all the way to the "Chimney," is of like character; and the same may be said about those lying at the base of Pomola, on the north and northwest sides of the high ridge of which it is the pinnacle. This ridge runs for two or three miles toward the southwest, and is three hundred feet above the table-land. The entire side of this hill is obstructed with granite boulders, generally angular, and some of them from ten to twenty feet square. The great blocks are heaped upon each other without order and to such a height that it is exceedingly difficult to climb over them.

I believe the top of Katahdin to have been overridden by the glacier, and that the ice-cap has everywhere degraded its summit, though, like Hitchcock, I saw nothing of the glacier polish and scratches there; nor should we expect to find them on so high an eminence composed of coarse granite, where no soil can accumulate to protect them from the eroding action of winter frosts. Prof. Hitchcock thinks that the northern sides of Katahdin at any considerable height have not been stossed by the drift agent.* I can say with great confidence, that the northern side of the mountain just below the "Monument," which is three thousand five hundred feet above the Wassattacook, washing the base of the hill, really "appears like one great stoss side," and is a glacially degraded wall, just as all our hills in Maine are, at all heights below that of Katahdin. We see boulders with rounded corners lying in place there, and wonder why they have not been toppled down the mountain by the winter frosts.

Furthermore, we have the fact of the disruption of the top of Katahdin into "strata," as Mr. Hitchcock designates them. On the south side of the mountain, just under the "Chimney," this disruption is very marked, apparently horizontal, though the sheets probably dip toward the south. Now

* Report of Scientific Survey for 1861, p. 396.

the case is that the strata everywhere slope from the shoulders of the mountain downward. On the north side, the dip is toward the north; on the east, toward the east; on the west, toward the west; and on the south, generally toward the south. This is the case with all the "granite" hills of Maine, and is referable to the action of the great glacier over them. This structure has *not* been superinduced by superficial changes of temperature," as Dr. Hunt conjectures, in Silliman's Journal, July, 1870, p. 88. Among all the quarries of Vinalhaven, the surface is broken into sheets or "platforms," and at all depths penetrated by the workmen. The deeper the quarry is worked, the thicker are the sheets. They are generally regular in their lines of fracture, running sometimes almost across the quarry, without much variation as to horizontality; and again we see the lines somewhat waved and distorted. The depths of these sheets in the quarries wholly exclude the idea of their origin being referable to variation of atmospheric temperature, or to any other cause, I think, than that of glacial action.* The first suspicion I had years ago of the enormous thickness of the great glacier, was suggested by these remarkable fractures. In the locality under the "Chimney," which I have just mentioned, where the formation is in sheets, and which is more than four thousand five hundred feet above the sea, quite a stream of water runs out of the fracture and falls into the "Avalanche Brook," which also, probably, has a similar origin. Wherever, therefore, the bare front of Katahdin is open to view, I think it will be found to be shattered as I have described; and in my judgment these effects must be referred to glacial action. Now the glacier could not have broken up the top of Katahdin, unless the ice-cap had been several hundred feet in thickness above the summit, to insure the pressure necessary to fracture the rock, in connection with the general progressive motion of the mass. It was the slow grinding motion of this ice-sheet which broke up all the surface of New England to great depths. I am therefore not disposed to estimate the thickness of the glacier at *less* than eight thousand feet, as I have done in my article on the "Motion of Glaciers," in Vol. I, Part II, of the Proceedings of the Portland Society of Natural History.

I add a word on the route to Katahdin.

Of the different routes to Katahdin taken by tourists, one is by way of the West Branch of the Penobscot, either down it by the way of Moosehead Lake, or up it from its junction with the East Branch; and by the way of Sherman to the Hunt Farm, and the Wassatacook Stream. On this route, the

* May not the origin of this structure antedate both the ice and the action of superficial temperature?—Eds.

path is generally taken to Katahdin Pond, and south to the mountain, though I should prefer the route up the Wassatacook to the place where Katahdin comes down to this stream, and so up the mountain from the north, where it is easier of ascent. Before the summit is reached in this direction, there is a chance to camp in the mixed growth of trees; and starting early, you can get over the top of the mountain without that exhausting labor which attends ascent by the other routes. The magnificence of this mountain is not appreciated without a visit to it. Its base above the surrounding country running north and south must be nearly ten miles long, and its top in this direction not far from six miles. The summit is in general flat, though having several peaks.

Art. VI.—*Tables for the Computation of Relative Altitudes;* by Cleveland Abbe.

[Communicated by permission of the Chief Signal Officer, U. S. A.]

The computation of relative altitudes by barometrical measurements is so conveniently performed by means of the tables published by Dippe in Schumacher's Jahrbuch, and given by Guyot as tables D IV of the Smithsonian collection, that I, some time ago, had occasion to transform these into the units of measure commonly used in the United States. I have not altered the constants given in the Smithsonian edition, but have extended the tables to a range sufficient to cover several extreme cases that have come to my notice. The daily use of the barometer in this country for hypsometrical determinations, leads me to think that the tables here presented will be as convenient to others as they have proved to myself.

The directions for the use of these tables are not different from those given on pages 54–57 of section D of the Smithsonian tables. It is assumed that there are given, the temperatures (t and t') in Fahrenheit degrees at the lower and upper station, the barometric readings (b and b') in inches and reduced to the freezing point, and also the latitudes or average latitude of the stations. The altitude h is found in American feet by the formula

$$\log h = \log u + A + c + c'$$

where

$$u = \log b - \log b'$$

and c and c' are the small corrections for the change in the force of gravity with the latitude and the altitude respectively.

Washington, Nov., 1871.

TABLE I.

$t+t'$ FAHR.	A		$t+t'$ FAHR.	A		$t+t$ FAHR.	A		$t+t'$ FAHR.	A	
−120	4·68081	60	−60	4·71583	56	0	4.74825	52	+ 60	4·77842	49
119	141	61	59	639	56	+ 1	877	52	61	891	48
118	202	61	58	695	56	2	929	52	62	939	48
117	263	60	57	751	56	3	4·74981	52	63	4·77987	49
116	323	60	56	807	56	4	4·75033	52	64	4·78036	49
115	383	61	55	863	55	5	085	51	65	085	48
114	444	61	54	918	56	6	136	52	66	133	48
113	505	60	53	4·71974	56	7	188	52	67	181	48
112	565	60	52	4·72030	55	8	240	51	68	229	48
111	625	59	51	085	55	9	291	52	69	277	49
−110	684	60	−50	140	55	+10	343	51	+ 70	326	48
109	744	60	49	195	56	11	394	51	71	374	48
108	804	60	48	251	55	12	445	52	72	422	48
107	864	60	47	306	55	13	497	51	73	470	47
106	924	59	46	365	55	14	548	51	74	517	48
105	4·68983	60	45	416	55	15	599	51	75	565	48
104	4·69043	59	44	471	55	16	650	51	76	613	47
103	102	59	43	526	55	17	701	51	77	660	48
102	161	60	42	581	55	18	752	51	78	708	48
101	221	59	41	636	55	19	803	51	79	756	48
−100	280	59	−40	691	54	+20	854	51	+ 80	804	47
99	339	59	39	745	55	21	905	51	81	851	48
98	398	59	38	800	55	22	4·75956	51	82	899	47
97	457	59	37	855	54	23	4.76007	50	83	946	47
96	516	59	36	909	54	24	057	50	84	4·78993	47
95	575	58	35	4·72963	56	25	107	51	85	4·79040	47
94	633	58	34	4·73017	54	26	158	50	86	087	47
93	691	59	33	071	54	27	208	51	87	135	47
92	750	59	32	126	54	28	259	50	88	182	47
91	809	58	31	180	54	29	309	50	89	229	47
− 90	867	58	−30	234	54	+30	359	51	+ 90	276	47
89	925	59	29	288	54	31	410	50	91	323	47
88	4·69984	58	28	342	54	32	460	50	92	370	47
87	4·70042	58	27	396	54	33	510	50	93	417	47
86	100	58	26	450	54	34	560	50	94	464	47
85	158	58	25	503	53	35	610	50	95	511	46
84	216	57	24	557	54	36	660	50	96	557	47
83	273	58	23	610	53	37	710	50	97	604	47
82	331	58	22	664	54	38	760	49	98	651	47
81	389	58	21	718	54	39	809	50	99	698	46
− 80	447	58	−20	771	53	+40	859	50	+100	744	46
79	505	57	19	824	54	41	909	50	101	790	46
78	562	57	18	878	53	42	4·76959	50	102	836	47
77	619	58	17	931	53	43	4·77009	49	103	883	47
76	677	57	16	4·73984	53	44	058	50	104	930	47
75	734	57	15	4·74037	53	45	108	49	105	4·79977	46
74	791	57	14	090	53	46	157	49	106	4·80023	46
73	848	57	13	143	52	47	206	50	107	069	46
72	905	57	12	195	53	48	256	49	108	115	46
71	4·70962	57	11	248	53	49	305	49	109	161	46
− 70	4·71019	57	−10	301	53	+50	354	49	+110	207	46
69	076	57	9	354	52	51	403	49	111	252	45
68	133	56	8	406	52	52	452	49	112	298	46
67	189	56	7	458	53	53	501	49	113	344	46
66	245	57	6	511	52	54	550	49	114	390	46
65	302	56	5	563	53	55	599	49	115	436	46
64	358	57	4	616	52	56	647	48	116	482	46
63	415	56	3	668	52	57	696	49	117	528	45
62	471	56	2	721	53	58	745	49	118	573	46
61	527	56	− 1	773	52	59	794	48	119	619	45
− 60	4·71583		0	4·74825		+60	4·77842		+120	4·80664	

TABLE I—Continued.

$t+t'$ FAHR.	A		$t+t'$ FAHR.	A		$t+t'$ FAHR.	A		$t+t'$ FAHR.	A	
+120	4·80664	46	+150	4·82010	44	+180	4·83315	43	+210	4·84583	41
121	710	46	151	054	44	181	358	43	211	624	42
122	756	46	152	098	44	182	401	43	212	666	41
123	801	45	153	142	44	183	444	43	213	707	42
124	846	45	154	186	44	184	487	43	214	749	41
125	891	45	155	230	44	185	530	42	215	790	42
126	937	45	156	274	44	186	572	42	216	832	41
127	4·80982	45	157	318	44	187	614	43	217	873	42
128	4·81027	46	158	362	44	188	657	43	218	915	42
129	073	44	159	406	43	189	700	42	219	957	41
+130	117	46	+160	449	44	+190	742	42	+220	4·84998	41
131	163	44	161	493	44	191	784	42	221	4·85039	41
132	207	45	162	537	44	192	826	43	222	080	40
133	252	45	163	581	44	193	869	42	223	120	42
134	297	45	164	625	43	194	911	43	224	162	41
135	342	45	165	668	44	195	954	42	225	203	41
136	387	45	166	712	42	196	4·83996	42	226	244	41
137	432	45	167	754	44	197	4·84038	42	227	285	41
138	477	44	168	798	43	198	080	42	228	326	41
139	521	45	169	841	44	199	122	42	229	367	41
+140	566	45	+170	885	43	+200	164	42	+230	408	41
141	611	45	171	928	43	201	206	42	231	449	41
142	656	44	172	4·82971	43	202	248	42	232	490	41
143	700	45	173	4·83014	43	203	290	42	233	531	40
144	745	44	174	057	43	204	332	42	234	571	41
145	789	44	175	100	43	205	374	42	235	612	41
146	833	44	176	143	44	206	416	42	236	653	41
147	877	44	177	187	43	207	458	41	237	694	40
148	921	45	178	230	43	208	499	42	238	734	41
149	4·81966	44	179	273	42	209	541	42	239	775	40
+150	4·82010		+180	4·83315		+210	4·84583		+240	4·85815	

II.—*Correction for Latitude.*

Lat.	c.	Lat.	c.	Lat.	c.	Lat.	c.
0°	+113	23°	78	45°	0	68°	−81
1°	113	24	75	46	− 4	69	84
2	112	25	+72	47	8	70	−86
3	112	26	69	48	12	71	89
4	112	27	66	49	16	72	91
	+111	28	63	50	−20	73	93
6	110	29	60	51	23	74	96
7	109	30	+56	52	27	75	−98
8	108	31	53	53	31	76	100
9	107	32	49	54	35	77	101
10	+106	33	46	55	−39	78	103
11	104	34	42	56	42	79	104
12	103	35	+39	57	46	80	−106
13	101	36	35	58	49	81	107
14	100	37	31	59	53	82	108
15	+ 98	38	27	60	−56	83	109
16	96	39	23	61	60	84	110
17	93	40	+20	62	63	85	−111
18	91	41	16	63	66	86	112
19	89	42	12	64	69	87	112
20	+ 86	43	8	65	−72	88	112
21	84	44	+ 4	66	75	89	113
22	81	45	0	67	78	90	−113
23	+ 78			68	−81		

III.—*Correction for Altitude.*

Difference of altitude.	c'.	Difference of altitude.	c'.
0 feet to 240	0	5050 feet to 5531	+11
240 " 722	+ 1	5531 " 6012	12
722 " 1203	2	6012 " 6493	13
1203 " 1683	3	6493 " 6974	14
1683 " 2164	4	6974 " 7455	15
2164 " 2645	5	7455 " 7936	16
2645 " 3126	6	7936 " 8417	17
3126 " 3607	7	8417 " 8898	18
3607 " 4088	8	8898 " 9378	19
4088 " 4569	9	9378 " 9860	+20
4569 " 5050	+10	9860 " 10341	21

NOTE.—c and c' are given in units of the fifth decimal place.

ART. VII.—*On the relative proportion of Iron and Sulphur in the "Pyrite" contained in several specimens of Iowa Coal;* by RUSH EMERY.

THE idea of making the following examination was suggested to the writer by a notice, in a former number of this Journal, of the results obtained by Prof. Wormley of the Ohio Geological Survey, in his analyses of the compounds of iron and sulphur found in the coals of that State. In these analyses the amount of sulphur was found too large for combination with the iron as FeS_2.

The method adopted in the following analyses was:—(1) A weighed quantity of the coarsely pulverized coal (see column 2 in the Table of Analyses) was soaked in water acidulated with a few drops of HCl, the object being to extract from the coal all mineral substances capable of solution by this treatment, and especially soluble salts of iron, the presence of which would vitiate the accuracy of the results with regard to the relative proportion of iron and sulphur in the insoluble compounds remaining. This solution was evaporated to dryness; and the weight of the residue thus obtained is given in column 3 of the following table. It will be noticed that, with a single exception, this soluble mineral matter exceeds in quantity the combined amount of iron and sulphur, as given in columns 4 and 6. Only a qualitative examination was made of the soluble matter, any more extended investigation of it being foreign to the main question. Very large quantities of Fe and H_2SO_4 were found in all the samples, thus showing the extent to which decomposition of a sulphide had already taken place. In most cases, however, there was little external evidence of decomposition. In Nos. 1, 2, 5 and 10, large amounts of Ca were found; in No. 3, a very small quantity; none in the

others. In all of the cases where Ca was found, CO_2 was also present, and especially in the first four named. It is believed that what is frequently regarded as gypsum in coal deposits, is in many cases a mixture of calcium carbonate and sulphate. In a large number of examinations of Iowa coals, made by the writer in connection with his labors as chemist of the late Geological Survey of that State, there were but few cases where the application of the test failed to show the presence of CO_2.

(2) The insoluble—by treatment (1)—iron sulphide was thoroughly digested with HCl and $KClO_3$: the solution thus obtained, after being boiled to expel Cl, was divided into two portions: Fe_2O_3 and $BaSO_4$ determined successively in each; Fe and S calculated; and the means of the two analyses taken. See columns 4 and 6.

It was also found by carefully testing the filtrate from the precipitate of Fe_2O_3, that Ca was present in but three cases, and then in very small amount.

The samples for analysis were selected with a view of obtaining the largest possible quantity of visible sulphide, while not excluding that which existed in a form invisible to the eye and disseminated through the coal.

The results of this investigation are given in the following

Table of Analyses.

No. of Analysis.	Quantity of coal taken.	Quantity of matter dissolved by H_2O+HCl.	Quantity of Fe in insoluble residue after digestion with HCl+$KClO_3$.	Quantity of S required to combine with the Fe found, in order to form FeS_2.	Quantity of S found.	Excess or deficiency of S. (D—column 5—col. 6; E—col. 6—col. 5).	Percentage of S in the compound of S & Fe. (See cols. 4 and 6.) In FeS_2, S—53·33 pr. ct.
1	19·479	3·388	·192	·219	·158	D. ·061	45·14
2	11·722	·785	·106	·121	·186	E. ·065	63·70
3	11·356	·484	·197	·225	·278	E. ·053	58·53
4	12·095	·396	·106	·121	·168	E. ·047	61·31
5	19·802	2·767	·362	·414	·409	D. ·005	53·05
6	17·290	3·819	·564	·645	·642	D. ·003	53·23
7	12·015	·480	·224	·256	·262	E. ·006	53·91
8	15·611	1·579	·244	·279	·429	E. ·150	63·74
9	22·767	1·703	·396	·453	·407	D. ·046	50·68
10	17·693	1·532	·250	·286	·284	D. ·002	53·18

It will be seen by the preceding table, that in Nos. 5, 6, 7 and 10, the relative proportion of Fe and S correspond nearly to that existing in FeS_2; in Nos. 2, 3, 4 and 8, there is a marked excess of S; while Nos. 1 and 9 give the unexpected result of a marked deficiency.

It is a source of regret to the writer that other duties have prevented the making of a larger number of analyses; but it

is to be hoped that others may contribute to the investigation of this subject.

The samples for analysis were furnished through the kindness of Dr. C. A. White of Iowa City, late Director of the Iowa Geological Survey.

Genesee Agricultural School, Lima, N. Y., Oct. 31st, 1871.

ART. VIII.—*On the Occurrence in nature of Amorphous Mercuric Sulphide;** by Dr. GIDEON E. MOORE.

IN the winter of 1867–68, my honored friend, Professor J. D. Whitney, chief of the State Geological Survey of California, directed my attention to a peculiar black mercury ore, which he had first noticed during a geological journey through Lake County, California, in the spring of 1863. From its very peculiar physical properties he had been led to conjecture that it might possibly, on investigation, turn out to be an isomorphous mixture of mercuric sulphide and selenide, analogous to the *Onofrite* of *Haidinger*.

I undertook the investigation, in conjunction with other items of analytical work, for the California Geological Survey. As however, the issue of the reports of this institution has been temporarily delayed, and as the results of the investigation have proven to be not without interest, I have decided, with Professor Whitney's kind permission, to make them at once public.

The mineral occurs lining fissures and cavities in a peculiar siliceous veinstone, and is associated with crystallized and massive iron and copper pyrites, and very small brilliant ruby-red crystals of cinnabar.

The latter, which are of prismatic habitus, show the combination I, $\frac{4}{5}$ (fig. 1), and are provided with terminal faces at one end only. Although brilliant, the faces do not give perfect reflections. The measurements therefore, which could only be made by observing the reflections of a lamp flame, are only approximately correct.

1.

The mean of six consecutive measurements gave:

	Found.	Calculated.
I ∧ 1	120° 14′	120°
I ∧ $\frac{4}{5}$	137° 42′	136° 36′.

In most of the specimens the minerals were arranged in the following order.

First, a layer of pyrites of moderate thickness, lining the walls of the cavity, then a proportionately thick layer of the

* From the Journal für prakt. Chemie, neue Folge.

black mineral in question, very irregular in thickness and full of cavities, lining which the cinnabar crystals occurred. The cinnabar occurs also in fine grains, in places so intermixed with the black mineral as almost to present the appearance of an intermediate stage between the two. This appearance is, however, only superficial; the lens always shows a sharp line of demarcation, for the cinnabar occurs always crystallized or crystalline, the black mineral always amorphous.* This admixture made it difficult to obtain enough of the pure mineral for investigation. By careful selection with the lens among the smaller fragments, a sample was, however, at last obtained, which presented the following properties.

Entirely destitute of structure or cleavage. Fracture subconchoidal to uneven, with brilliant surfaces. Very brittle when struck or bent, but tough under the knife. In the agate mortar the powder packs readily under the pestle, and takes a high polish and metallic luster, similar to graphite. Color greyish black. Streak on porcelain pure black. Luster metallic. Cuts with a shining surface. Hardness about 3 of Mohs' scale, somewhat greater than that of cinnabar, but difficult to determine exactly on account of brittleness. Specific gravity 7·701 to 7·748, varying somewhat in different specimens, owing to intermixed cinnabar.

Pyrognostic characters those of cinnabar. In the closed tube it sublimes totally except a slight residue of quartz and ferric oxide. The black sublimate yields a vermilion red powder when care has been taken, that, during the sublimation, the temperature of the upper part of the tube has not been very much lower than the subliming temperature of cinnabar. The experiment succeeds best in vacuo; the residue is then not oxide but sulphide of iron.

A qualitative analysis showed the presence of mercury and sulphur, with very small quantities of iron and silica. The quantitative analysis was made in duplicate, as follows:

* In all of the six or seven specimens which I had examined previous to the publication of this paper, the mineral occurs, as stated, without a vestige of crystalline structure. Mr. Emil Durand, of San Francisco, has, however, discovered specimens in which minute black crystals occur, and published a notice of his discovery in the San Francisco papers.

Through the kindness of Prof. Geo. J. Brush, I have had the privilege of examining two of Mr. Durand's specimens. The crystals are quite small, very irregularly developed, and betray in their frequent re-entrent angles a strong tendency to the formation of twins. In some cases, instead of simple individuals they appear to be aggregates of minute crystals. The habit is frequently almost *cubical*, and strikingly different from that of the long prismatic crystals of cinnabar which occur intermixed with and often implanted on them.

Unfortunately none of the specimens are sufficiently perfect to permit a determination of the crystalline form. The difference in habit is, however, sufficiently striking to warrant the supposition that they are probably *not* isomorphous with cinnabar.

I. (*a*) 1·4065 grm., decomposed by Woehler's method with chlorine gas yielded $BaSO_4$ 1·4130 grm., insoluble matters (quartz) 0·0036 grm. (*b*) 0·8310 grm. yielded HgS 0·8290 grm, Fe_2O_3

II. (*a*) 1·4893 grm., oxidized with chlorine gas in solution of caustic potash, gave $BaSO_4$ 1·5010 grm., quartz 0·0040 grm. (*b*) 1·2365 grm., oxidized with nitro-hydrochloric acid, yielded HgS 1·2320 grm., Fe_2O_3 0·0035 grm. 0·0081 grm.

These figures correspond to the following percentage composition:

	I.	II.	Mean.
S	13·79	13·84	13·82
Hg	85·69	85·89	85·79
Fe	0·33	0·45	0·39
Quartz	0·26	0·24	0·25
			100·25

which in its turn corresponds to:

HgS	98·92	containing	13·64 S.
FeS_2	0·83	"	0·44 S.
Quartz	0·25		----
	100.00		14·08 S.

The mineral is, therefore, simply mercuric sulphide with a little intermixed pyrites and gangue, the cause of the black color, absence of crystalline structure, and low specific gravity, which distinguish it so strikingly from cinnabar, remaining still to be ascertained. In spite of the very satisfactory result of the quantitative analysis, traces of coloring matter might, in this, as in the qualitative analysis, have escaped observation. That the color is not due to the small amount of iron pyrites is evident; Bealey,* for instance, found in his analysis of a beautiful red cinnabar from California as much as 1·40 per cent of *iron*. The only *volatile* matters which might be supposed capable of producing such a coloration are *selenium*, tellurium (?), arsenic (?), antimony,† and lastly bituminous compounds, such as those to which *Idrialite* owes its dark color. The large quantity of sulphureted hydrogen precipitate obtained during the analysis might easily have concealed traces of the first named substances, while carbon compounds would naturally only reveal themselves to special tests, therefore:

The barium sulphate, obtained during the analysis, was ignited in a current of hydrogen, as in the quantitative separation of selenium from sulphur, whereby a very slight reduction to barium sulphide ensued. The powder evolved a trace of sul-

* Quart. Jour. Chem. Soc., vol. iv, p. 180, and Jour. für prakt. Chem., lv, 234.
† Wehrle Ann. Chem. Pharm., viii, 181.

phureted hydrogen with hydrochloric acid, but did not lose appreciably in weight. Furthermore, 3 grams of the mineral were fused with sodium carbonate and potassium nitrate; the mass, boiled with hydrochloric acid to reduce selenic and telluric to selenous and tellurous acids, and then treated with sulphurous acid, gave no precipitate even after long standing. A control experiment, carried out on the same quantity of the mineral, to which a few milligrams of selenium had previously been added, gave a very good reaction.

Three grams were fused with sodium carbonate and potassium nitrate. The result, when treated after the usual routine of a qualitative analysis, gave no trace of arsenic, antimony or any other impurity.

The powdered mineral yielded no bitumen to ether. 2,1751 grams were, therefore, burned with lead chromate as in an organic analysis and the resulting gases, after passing over a stretch of ignited metallic copper, conducted into baryta water. No precipitate was formed until, toward the end of the operation, a current of air was passed through the apparatus. The trifling precipitate, which then came down, was quickly filtered off, washed and dissolved in hydrochloric acid, to which some chlorine water had previously been added, to oxidize any sulphurous acid which might still be present. After standing some time, the fluid was filtered from the traces of barium sulphate, which had precipitated, and the baryta thrown down as carbonate. The precipitate weighed 0·0155 grms., corresponding to *carbon* 0·0010 grms., or 0·04 per cent of the original mineral, a quantity so small that it may be safely ascribed to the imperfect purification of the air used in the combustion.

No chemical reason for the peculiar difference in properties from cinnabar could, therefore, be detected.

Mercuric sulphide, as prepared in the laboratory, exists in two forms, which were first recognized by Berzelius as distinct isomeric modifications. The first of these is the black precipitate produced by sulphureted hydrogen in solutions of mercuric salts. The second, obtained from the first by long continued agitation, treatment with alkaline sulphides, etc., is the crystalline red powder, *vermilion*. Only the latter variety, under the name of *cinnabar*, has hitherto been recognized in nature. The assumption lay near that I had to do with the one first named, especially, as the very low specific gravity could not be accounted for by the presence of *traces* of impurities. The natural cinnabar has a specific varying from 8·0 to 8·2, in the mean 8·1. Taking the latter number as a basis, the specific gravity calculated for a mixture like the one in question would be 8·0165, whereas it is in fact 7·701.

The most convincing proof of the correctness of this supposition was afforded by the direct conversion of the mineral into the red modification. A small portion was triturated with water to the finest powder, sealed in a tube with solution of potassium pentasulphide, and exposed to the temperature of boiling water. The powder, which was pure black at first, showed on the morning of the third day a decided tinge of red. As soon as no further change could be perceived, the tube was opened. The powder then showed a brownish red color, not of course to be compared with vermilion, but still quite satisfactory to one familiar with the refinements of manipulation required to produce the finer shades of color in the latter substance, and, perhaps, all that could be expected, in view of the great difference in susceptibility to chemical action usually existing between a native mineral and an artificial precipitate.

It was still desirable to compare the specific gravity of the mineral with that of the black precipitated mercuric sulphide. As, however, I have been unable to find any recorded determination of the latter, it was necessary to determine it myself. This was at first no easy matter. The precipitate possesses in an eminent degree the annoying peculiarity of retaining, with great tenacity, a coating of air, which makes a perfect admixture with water well nigh unattainable by ordinary means. When boiled, the mixture spirts with almost explosive violence, and forms in addition a greasy-looking scum, which cannot be made to sink. Attempts to use the air-pump in the ordinary manner were likewise unsuccessful, on account of the strong foaming which ensued. I was, therefore, obliged to have recourse to an expedient of which, as it may perhaps be useful to others in similar difficulties, a detailed description may not appear superfluous.

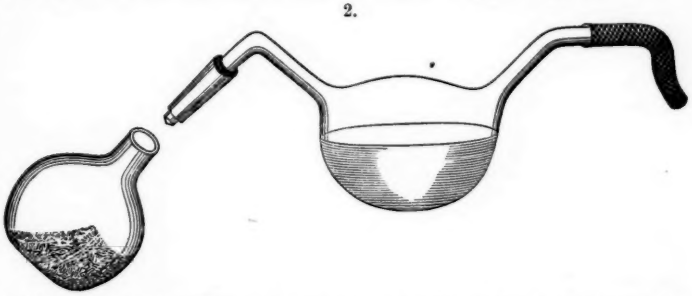
Pure mercuric sulphide was prepared by the action of sulphureted hydrogen on solution of mercuric nitrate. Every care was taken to insure perfect saturation, and, after thorough washing and drying, the mass was repeatedly digested with pure carbon disulphide, until all free sulphur had been removed.

After careful drying, a weighed portion was placed in a weighed specific gravity flask of the ordinary pattern. This was connected with a Bunsen's pump,* by means of a triply bent tube, fig. 2, whose middle part had been widened out into a bulb of about equal capacity with the flask itself, the communications between the bulb-tube, which was filled to three-fourths with water, and the flask being made air-tight by means

* As Bunsen's pump is not always to be found so perfect in construction as to permit the attainment of the maximum degree of rarification, it may be preferable in most cases to use Sprengel's mercury air-pump.

of a moist rubber collar. As soon as the manometer of the pump indicated the maximum of rarification, the apparatus was

2.



inclined, whereby the water ran quietly from the bulb into the flask, penetrating every pore of the mass within it without forming a particle of scum. It was only necessary to remove from the pump, fill up with water, and, as soon as the temperature of the balance room had been attained, to weigh.

Three determinations made in this manner on respectively 1·9750, 3·8337 and 3·1155 grams, gave for the specific gravity the numbers 7·552, 7·551 and 7·553, in the mean 7·552 compared with water at 15° C.*

A sample of vermilion, whose specific gravity had been ascertained to be 8·090, was reconverted into the black variety by the method of Fuchs',† by heating until the temperature of sublimation was just attained, and then plunging suddenly into cold water. (The operation was performed in an atmosphere of carbonic acid.) The powder, however, conducts heat too slowly to be instantaneously cooled throughout its whole extent, consequently a perfect conversion could not be effected. The dark grayish black powder showed a specific gravity of 7·980, and assumed a reddish color by pulverization.

I think the foregoing results are sufficient to establish the complete identity of the mineral in question with the amorphous mercuric sulphide of the laboratory. The slight difference in specific gravity is partly due to the impossibility of getting enough of the mineral for a specific gravity determination, entirely free from admixture with cinnabar, partly probably to the fact that artificial precipitates almost invariably differ slightly in this respect from native minerals.

* It is worthy of note, that the above specific gravity agrees very well with that calculated from the specific gravities of the ingredients. Accepting as a basis for calculation the specific gravity of mercury at 0° C., 13·5959 (Regnault), and that of rhombic sulphur 2·045 (Marchand and Scheerer), we have for the *atomic volume* of mercuric sulphide 15·1792, which corresponds to the specific gravity **7·6428.** A still more perfect accordance is the result when we employ the specific gravity of monoclinic sulphur, 1·982 (M. & S.); we then obtain the number **7·5188.**

† Pogg. Ann. xxxi, 581.

To facilitate comparison, I have arranged the properties of the native red and black and the artificial black mercuric sulphide in the following table:—

Red (native).	Black (native).	Black (artificial).
Always crystallized or crystalline.	Always amorphous.	Heavy black amorphous powder, takes by pressure a high polish and metallic lustre. Obtained by sublimation as a black amorphous mass, with metallic lustre. (*Fuchs*, loc. cit.)
Cleavage, perfect.	Totally destitute of cleavage.	
Lustre, adamantine, inclining to metallic in the darker varieties.	Lustre, metallic.	
Color, cochineal red, inclining to brownish and lead gray.	Color, grayish black.	
Streak, scarlet.	Streak, black.	
Specific gravity, 8·0—8·2.	Specific gravity, 7·701.	Specific gravity, 7·552.

The difference between the two minerals seems to me greater than that between two *varieties* of the same species. I cannot see why the rule by which diamond and graphite are classed as distinct species, should not also be applicable in this instance. I feel therefore warranted in introducing this mineral to science as a new species and in assigning to it, under the name *Metacinnabar* (Metacinnabarite), a position distinct from that of its isomer cinnabar.

It is not improbable that the mineral has been hitherto confounded with the darker varieties of cinnabar, from which, however, its destitution of crystalline structure, black streak and low specific gravity, eminently distinguish it.

The arrangement of the minerals in the vein would seem to favor the following theory of the formation of the meta-cinnabar. The pyrites were evidently first deposited, possibly by aqueous agency. If now, into a cold cavity thus lined, vapors of mercuric sulphide were to be admitted, they would condense, not to the red, but to the black modification, as Fuchs' method of preparing the latter sufficiently demonstrates. Later, as the temperature of the surrounding mass had become somewhat raised, the red variety would begin to form, and we accordingly find in all the specimens that the crystals of the latter occur coating the black. The fine granular mixture of both may have been the result of an intermediate degree of temperature, or, what is more probable, as it does not occur in all the specimens and is sometimes included between two layers of nearly pure meta-cinnabar, it may have resulted from a gradual alteration in molecular condition from this mineral to cinnabar. This theory would derive additional probability from the fact that the mineral occurs in a region abounding in the most striking evidences of volcanic action.*

* Vide Whitney's Reports of the Geological Survey of California, vol. i, Geology, p. 80, et seq.

At its locality* the mineral occurs in considerable abundance, and, according to the statement of the president of the company, H. P. Livermore, Esq., of San Francisco, to whose kindness I am indebted for the material for this investigation, constitutes the most abundant and valuable ore of the mine.

ART. IX.—*Norian Rocks in New Hampshire;* by C. H. HITCHCOCK, State Geologist of New Hampshire.

DURING the past summer (1871) I have made a reconnaissance of the southwest part of the White Mountains, or the district bounded north by the Ammonoosuc River, east by the Saco, south by the towns of Sandwich and Tamworth, west mostly by the Pemigewasset River. This area is entirely a forest country, with several alpine summits covered by dwarf-spruces, and as even logging roads are scarce, geological explorations were carried on with extreme difficulty. With the aid of several gentlemen from the class of 1871, Dartmouth College, the greater portion of this area has been traversed, and enough specimens have been brought out to enable us to form some idea of the different groups existing in this *terra incognita.* The search has brought to light formations hitherto supposed to be entirely alien to New England; and perhaps the key has been discovered which shall open to us the stratigraphical structure of the whole State. I refer to the discovery of massive labradorite and the associated minerals of the *Norian or Upper Laurentian Group.* These cover an area of several square miles in Waterville and Albany, adjoining towns, and probably occur in other parts of the State also. Whether the various gneisses, granites, felsites and jaspers in this part of the mountains, all differing from anything found elsewhere in the State, are to be assigned to the same series, remains to be proved. The occurrence of the labradorite in a new locality is of special interest at this time, when scientists are discussing the fundamental question, whether certain predominant minerals in metamorphic formations may be employed like fossils to indicate difference of geological age.

At the Montreal meeting (1857) of the American Association for the Advancement of Science, Sir W. E. Logan announced† that the Laurentian rocks could probably be divided into two groups, dependent upon the species of feldspar present, the potash feldspars characterizing one, and the lime and soda feldspars the other portion. This position is not discussed in

* The "Redington Quicksilver Mine," Lake County, California.

† Proc. Amer. Assoc. Adv. Sci., 1857, p. 47.

the Geology of Canada for 1863, except in a supplementary chapter, where, on page 836, considerations are presented favoring the view that the anorthosite group rests unconformably upon the orthoclase gneisses. The Canadian Survey proposed to call this new group the Upper Laurentian or Labrador system. Recently* Dr. T. Sterry Hunt has briefly described the various localities where these rocks occur, and proposed for them the designation of *Norian*, after Norite (from Norway), a name early used for a labradorite rock in Norway; presenting also further evidence to show the unconformable superposition of the Norian upon the Laurentian.

The most easily accessible locality is in Waterville, a small mountain hamlet in the southern part of the elevated district, about twenty miles northeasterly from Plymouth. For the convenience of those who may wish to visit this place, it may be said that a daily stage runs from Plymouth, the head quarters of the Boston, Concord and Montreal Railroad, to Greely's Hotel, a house kept open during the summer months. The accommodations are good, and the house is less than two miles distant from the first of the labradorite exposures, the route being by a footpath through the woods, passing a picturesque cataract. Inquiry must be made for the "slide upon Mount Passaconnaway." As soon as the end of this so-called slide is reached, the observer will find an immense amount of boulders and drift wood that were brought down in the great freshet of Oct., 1869. The facts concerning this great "wash-out," have been well described by Dr. G. H. Perkins, to whose description the reader is referred† for further topographical details than are given here. The rock which Dr. Perkins speaks of as "hornblende," proves to be the massive labradorite. Mr. J. H. Huntington went over this slide in 1870, and brought back a number of specimens which appeared to be labradorite; one was sent to Dr. Hunt, who wrote as follows concerning it, about eight months since. "The specimen brought by Mr. Huntington is a Labradorite or Norite rock, which resembles in composition and aspect that of the Labradorian; with this difference, however, that it is much more tender and friable, and in this respect resembles the granitic gneisses of the White Mountains as compared with similar rocks in the Adirondacks." I was not able to visit the locality myself till August 18 and 19, and subsequently on September 20, in company with Professor Dana; whose views with regard to the nature of the rock confirmed those I had previously entertained.

The great freshet coming down from the south side of Mount Passaconnaway, or the most southern of the "Tripyramid," has exposed many ledges that would otherwise have remained con-

* This Journal, II, vol. xlix, p. 180. † Do., p. 158

cealed, on account of the easily decomposing character of the labradorite. The first rock seen is a gneiss with nodular orthoclase, dipping by compass about 80°, S 70° W. The strata are indicated by folia of a dark hypersthenic mineral, often forming bunches or nodules. Jointed planes dipping about 25° westerly might be mistaken for strata. One might be so easily deceived, that it seems as if they must be the planes described at the Cascades and on Mount Osceola by J. P. Lesley.* This mountain is certainly composed of similar rock, and it covers quite a large area to the west and south.

A few rods higher up the stream, which I propose to call *Norway Brook*, the first ledge of the labradorite rock appears. Its junction with the gneiss is concealed by drift. For about a mile the ledges are mostly composed of this rock, a compound of labradorite and chrysolite, some exposures appearing for sixty or seventy feet. It is a perplexing matter to determine the lines of stratification, as the outcrops are divided by two prominent sets of jointed planes either of which might be called layers of deposition, the rock being essentially homogeneous. One set dip about 20° northerly and are the most numerous. The other dip about 75°, W. 10° S. The latter correspond better in position to the gneissic strata first seen than the former. This band of dark-colored rock, by some mistaken for basalt, is abruptly succeeded by a syenitic rock, fine-grained, with little quartz and mica. The feldspar seems to be Labradorite. The line of junction is irregular, averaging the course N. 20° E., while the dip of the plane of separation is about 85° westerly. Some of this feldspathic rock has been injected into irregular cavities of the dark Norite. Still higher up, the stream has cut a deep notch into the mountain; and the rock is coarser grained, consisting of whitish feldspar, which also is Labradorite according to recent analyses (see beyond), with hornblende, titanic iron, and a little epidote. This stream has worn its way along a ferruginous band, which may indicate the true position of the strata, dipping E. 15° S. and E. 35° N. The surface is almost entirely decomposed, though recently uncovered. Large nodules of essentially the same rock, but very tough, abound; also geodic cavities with orthoclase, albite, quartz and rarely stilbite. Above the notch the rock is like that immediately succeeding the dark compound of labradorite and chrysolite, with geodes, or feldspathic veins. At the point where the slide proper commences, and the valley turns at right angles, the dip curves, and a new variety of feldspathic rock is first seen, which continues to the top of the mountain, the southern of the three pyramids of Passaconnaway. There is very little quartz, but two kinds of feldspar, one of them reddish, probably orthoclase.

* Proc. Amer. Acad. Sci., Philadelphia, 1860, p. 363.

Mica is abundant, and some specimens show hornblende in its place. The rock has a syenitic aspect, and it also contains the same geodes as the rocks below, with actinolite, amethyst and other minerals not seen before.

This single line of exposure is the only one thus far examined, as the ledges farther north are entirely concealed by drift. It would seem as if those highest up topographically might be the lowest stratigraphically. With our present knowledge, nothing depends upon the immediate decision of this question, so far as the Norian bands are concerned. The lowest would be the reddish syenite, next a gray syenite, next the white easily-decomposing compound of similar character, next the gray syenite, and last of all the labradorite and chrysolite. These are all Norian. If the strata are to be regarded as dipping west nearly vertically, and not inverted, then the nodular gneiss first mentioned probably overlies the labradorite series.

In order to determine the adjacent formations, I examined first the valley of Cascade Brook, which is parallel with Norway Brook to the south, and from a quarter to half a mile distant. At the Cascades the same nodular gneiss first mentioned appears. Above that porphyritic gneiss occurs, much disturbed, but averaging a dip of 75°, N. 20° E. This course is nearly at right angles to the one thought to be that of the Norian rocks; or, if the other sort of planes be accepted as the true planes of deposition, the latter would appear to overlie the porphyritic gneiss unconformably. This latter rock covers the whole south-east part of Waterville, extending five or six miles southerly into Sandwich, and is part of the great mass which has been traced as far south as Fitzwilliam, if not through Massachusetts, sometimes fifteen miles wide. To the north of Norway Brook no very satisfactory explorations have been made. The specimens obtained were of nodular gneiss. To the north-east and east, the information is much more satisfactory. The whole of Passaconaway seems to be syenite. Additional facts are thus stated by J. H. Huntington, Assistant Geologist:

"On the east side of Tripyramid Mountain, and west of Sabba Day Brook, a branch of Swift river, the labradorite is so distinctive in its characteristics that it is easily recognized, and what is remarkable, some of the cleavable crystals show the play of colors. South it passes into a breccia, which overlies a well defined gneiss, and north we find the same syenitic rock that outcrops in the slide on the south-west side of the south peak of Tripyramid Mountain. Extensive as this rock is in Waterville, it is not limited to this locality, for the whole south-east slope of Chocorua is labradorite, and it is not improbable that it extends from Waterville through the town

of Albany. On Chocorua, the labradorite outcrops in the slide that is generally followed by people who ascend this mountain."

Since my visits to Waterville, I have found similar syenites to those of Passaconaway, together with very interesting breccias not unlike those of Albany, upon Gunstock and Belknap mountains in Gilford. These locations are near Winnipiseogee Lake, and also occur in connection with porphyritic gneiss. Red Hill in Moultonboro is also composed of a similar syenite, though I have not seen in it any labradorite. It seems to lie upon a gneissic synclinal; other localities of similar character are Lightning Mountain in Strafford, and Mt. Monadnock in Vermont, close by Colebrook, on the upper Connecticut. The Quincy syenite of Massachusetts is said to lie contiguous to porphyritic granite in Abington, Mass., and its extension into New Hampshire, in Seabrook, is accompanied by porphyritic gneiss, with crystals of feldspar less conspicuous than usual.

Rocks in this mountainous district recently brought to light, and possibly related to the Norian or Huronian, are the jaspers of Albany and Twin Mountain, and extensive deposits of felsite capping Lafayette, Flume, Liberty, Twin, and other mountains. Chemical examination may show them to be related to the lime feldspars. They will be analyzed in due time.

There is an abundance of material afforded by these facts for speculating upon the ages of the metamorphic rocks in New Hampshire and Massachusetts. One cannot avoid forming conclusions as fast as new facts present themselves; but as I hope to be able to make further investigations in this field, it will be best to reserve our inferences for some other occasion, when additional information may afford more satisfactory results.

I am happy to state, in closing, that the minerals of the Waterville rocks have been recently under chemical investigation by Mr. Edward S. Dana, at New Haven; and that it is through his analyses that I am able to state confidently, that the mineral mainly constituting the dark-gray Waterville rock is, as Mr. Hunt had suggested, labradorite. By the same means I have learned that the light colored feldspar, from the upper locality at Waterville, very unlike the other in aspect and much resembling common feldspar, is also labradorite; and that the yellow mineral of the dark labradorite rock is chrysolite. Mr. Dana has consented to publish his results in an article following this.

Hanover, N. H., Dec. 1, 1871.

ART. X.—*Contributions from the Laboratory of the Sheffield Scientific School.* No. XXIII.—*On the Composition of the Labradorite rocks of Waterville, New Hampshire;* by E. S. DANA.

THE specimens of labradorite rock, which I have had under examination, were obtained by Professor Dana last September, on a visit with Prof. Hitchcock to the locality at Waterville, New Hampshire.

There are two distinct varieties, both mentioned by Prof. Hitchcock in the preceding article. The first (see page 45, line 13, et seq.) is a dark-colored rock, consisting in the main of a triclinic feldspar, together with small yellowish grains of a mineral, which Prof. Brush in a blowpipe examination referred to chrysolite. A careful examination reveals to the eye also some minute grains of a magnetic ore of iron, and also a very little of a black mineral, probably hornblende.

The feldspar has a dark smoky color, without iridescence, and is beautifully striated. It fuses B. B. with somewhat less readiness than ordinary labradorite, and is scarcely attacked by acids. It was picked out as carefully as possible, and analyzed with the following result:

	I.	II.	III.	Mean.
SiO_2	51·04	51·02	....	51·03
Al_2O_3 (TiO_2)	26·34	26·07	....	26·20
Fe_2O_3	4·79	5·13	....	4·96
CaO	14·09	14·23	....	14·16
NaO	....	....	3·44	3·44
KO	....	....	·58	·58
				100·37

The large percentage of iron (determined volumetrically) had not been expected, as the eye had failed to detect any impurities in the fragments selected for analysis. Some very thin pieces were afterward examined under the microscope; and by this means it was found that even the clearest pieces contained very minute grains of an iron ore, from $\frac{1}{3}\frac{1}{0}$th to $\frac{1}{2}\frac{1}{0}\frac{1}{0}$th of an inch in diameter, which were strongly attractable by the magnet. Microscopic dark specks less than $\frac{1}{1}\frac{1}{0}\frac{1}{0}\frac{1}{0}\frac{1}{0}$th of an inch in size were also observed and at first referred to the same cause, but on magnifying them 800 diameters, it was concluded that they were air-cavities in the structure of the feldspar, and not any foreign matter. The peculiar dark-smoky color of the rock is doubtless to be explained by the presence of these particles of iron ore.

This magnetic iron ore, a sufficient amount for the test having been picked out by the magnet, gave a decided reaction for

titanic acid. It is, therefore, probably a very magnetic titanic iron, though it was impossible to obtain a sufficient amount of the substance for a quantitative determination of the titanium. The absence of any octahedral faces or isometric structure in the grains is in favor of their being titanic iron.

In consequence of this impurity, which could hardly be removed, it is not to be expected that the analysis should give a satisfactory formula; the result obtained, however, is sufficient to prove that the feldspar is unquestionably labradorite.

The analyses of the mineral, supposed to be chrysolite, occurring in yellow, glassy grains, afforded:

	I.	II.	Mean.
SiO_2	38·82	38·88	38·85
Al_2O_3	tr.	tr.	tr.
FeO	28·00	28·15	28·07
MnO	1·12	1·36	1·24
MgO	30·88	30·36	30·62
CaO	1·26	1·60	1·43
	100·08	100·35	100·21

The oxygen ratio of the bases and silica afforded is nearly 1 : 1, and of the iron and magnesia about 1 : 2; whence the formula $(\frac{1}{3}\dot{F}e+\frac{2}{3}\dot{M}g)_2\ddot{S}$. This is then a chrysolite containing an unusually large per-centage of iron (here a constituent of the mineral, and not owing to the presence of impurities). The amount of iron is not strange considering the fact that the rock contains diffused throughout it so much free iron ore.

This chrysolite has the same ratio deduced for hyalosiderite, bnt still differs widely in fusibility and other characters. It is in fact a true chrysolite in all respects, while hyalosiderite is a doubtful compound, probably owing its fusibility in part to the potash present. B. B. the chrysolite is nearly infusible.

In two samples of this labradorite rock, obtained with care so as to represent the average composition, 1·70 and 1·94 (mean 1·82) per cent. of MgO were obtained, which would give 5.94 as the per-centage of the chrysolite in the whole.

This rock, consisting of labradorite with grains of chrysolite disseminated through it, is one not previously described. Prof. Hitchcock has proposed to call it *Ossipyte*, after the name of the tribe of Indians (the Ossipees) formerly inhabiting that region.

The second variety of the rock (for position, etc., see page 45, 16th line from foot) presents quite a different appearance. The feldspar, here in large, cleavable masses, often half an inch long, and a dark mineral, the angle of whose cleavage planes proves it to be hornblende, form the mass; together with these

are associated a magnetic titanic iron in segregated masses of some size, very little of a dark brown mica, and a green mineral, probably epidote. There is no chrysolite.

This feldspar has a grayish-white color, is destitute of iridescence, and only careful searching reveals any striations.

Two analyses afforded:

	I.	II.	III.	Mean.
SiO_2	52·15	52·36	....	52·25
Al_2O_3	27·63	27·39	....	27·51
Fe_2O_3	1·09	1·07	....	1·08
MgO	·92	1·06	....	·99
CaO	13·10	13·45	....	13·22
NaO	....	....	3·68	3·68
KO	....	....	2·18	2·18
				100·91

Both analyses show that the labradorite of the region is remarkable for the large proportion of lime present.

Art. XI.—*Recent German Arctic Explorations.*

1. *Letter of* A. Petermann, *dated Gotha, Oct.* 9, 1871.

It will be remembered that the present polar exploration was first agitated on this account; that Captain Osborn, R. N., almost seven years ago, proposed a new English expedition which had in view to explore the central arctic region, and to reach the North pole. The plan was to go up Baffin's Bay and through Smith's Sound; and had it received hearty approval and support among nautical and scientific circles, and with the authorities of England, there was every prospect that the English government would have equipped and sent out a large scientific expedition.

But when I submitted to the English authorities my views and project, which recommended the European North sea between East Greenland and Nova Zembla for the course of such an expedition, the plan of Capt. Osborn was set aside after the most thorough discussions of the most distinguished men at four meetings of the Royal Geographical Society at London, and acquiescence and recognition were accorded to my views. And while the English were, for seven years, satisfied with mere words and discussions, the remarkable readiness and generosity, and the lofty scientific and national feeling of the German nation made possible the equipment and sending out of two German scientific north-polar expeditions, under the command of Captain Koldeweg.

Besides this, at the same time extensive explorations, in the direction recommended by me, were set on foot by Dr. Dorst and Dr. Bessels in ships from Rosenthal, and by Count Zeil and Herr von Heuglin out of their own means, and important results were

attained. The ice-sea fisheries have taken an important advance, so that Norwegian fishermen have gained a revenue which realized a dividend of 57 per cent., and in addition most valuable scientific observations and discoveries have been made.

Captain Koldeweg has lately expressed himself publicly that he was quite of Capt. Osborn's opinion in regard to a North-polar expedition, he believing the route through Smith's Sound altogether the best. But I do not think that he will obtain from anyone the money for a German expedition, which is to be prosecuted according to an English plan, abandoned by the English themselves, and for which he nevertheless considers two steam vessels and an equipment for at least three years as necessary.

Immediately after the second German North-polar expedition, in consequence of the difference of opinion between Koldeweg and myself, very uncomfortable differences arose, which are now greater than ever, while Koldeweg, as already mentioned, adopts principles the opposite of mine, and has gone over to Capt. Osborn and the English, and in relation to the whole eastern half of the European North sea has made the following public assertion,—"To wish to reach the North pole (between Spitzbergen and Nova Zembla), I should consider an entirely wrong undertaking, and should only join myself to an expedition sent there by this route, in case Dr. Petermann in person made the journey with me." For this view he gives no reason, as if he, Captain Koldeweg, did not need to have or to name any ground for his opinions and assertions.*

But to how little extent Capt. Koldeweg's views were shared by other experienced and scientific men, is evident from this, that while he expressed that decision in the past May, already in June an expedition started out which had especially in view the exploration of that sea which Koldeweg was disposed to investigate only in my company; and what is more, with this expedition there went his own companion, the deserving Lieutenant Julius Payer, with the well-qualified Lieutenant Weyprecht, a native of Baden, from the village of König in Odenwald.

Contrasted with the last expedition led by Koldeweg, the courage and eminent scientific minds of these men could not but have been recognized, even if they had had little success, because they set out with the most scanty means and merely a little hired Norwegian sailing vessel, while Koldeweg started with two fine ships, elegantly fitted up. The latter, with steam vessels, in two summers, merely reached to 75° 31′ N. lat., only ¼° farther than Clavering 47 years before, and with sledges to 77° 1′ N. lat., while Payer and Weyprecht with the little sailing vessel, in that formidable sea, sailed to 79° N. lat., a distance, compared with their predecessors in that search, which exceeded at least tenfold those with Koldeweg.

The telegram which announced the return of Payer and Weyprecht from the extreme north to Trompsoë on the 3d of October, reads literally: "September offenes Meer von 42° bis 60° Oestlicher

* Hansa, 1871, No 10, S. 92.

Länge von Greenwich über 78° N. Breite verfolgt. Gröste Breite 79° N. Br. auf 43° Oestl. Länge, hier günstigste Eiszustände gegen Nord wahrscheinliche Verbindung mit Polynia gegen Ost, wahrscheinlich günstigster Nordpolweg."

The last part of the telegram is unintelligible, but I have reason for understanding it in this way, that King-Charles-Land, discovered in former years by Count Zeil and Herr von Heuglin, extends toward the south to 77° 12′ N. lat. Of this discovery and their work in East Spitzbergen in general, Count Zeil and Herr von Heuglin have won the most hearty acknowledgment from the Royal Geographical Society of London and from their late President, Sir Roderick Murchison.

The voyage and discovery of Payer and Weyprecht prove how little heed is to be given to the views and assertions of Capt. Koldeweg, but besides how much honor such explorers as Payer and Weyprecht deserve for their treatment of such errors, for their courage, and their high scientific enthusiasm.

In addition, it follows that all news hitherto made known from our European North sea had been announced under remarkably unfavorable conditions of ice and weather. It is to be supposed that Payer and Weyprecht evidently had to pass through a belt of drift-ice, before they reached that open Polar Sea extended over 18 degrees of longitude, and that they for the first time actually broke the North-polar ice belt just as Ross and Weddell had done at the South pole. In my chart (published June, 1870), in regard to the Gulf Stream, I have in accordance with the observations of Bessel, made in the Rosenthal steamship "Albert," of 1869, marked the Gulf Stream between 75° and 76° N. lat., which there* moreover shows a temperature of 41° F. and more at the sea surface. The name Gulf Stream, and the arrow on this chart† sufficiently mark the spot in 79° N. lat. and 43° E. long. (from Greenwich), which Weyprecht, as qualified and scientific as he is a thoughtful naval officer, in his telegram expresses as the "günstigsten Eiszustände gegen Nord der wahrscheinlichen Verbindung mit der Polynia gegen Ost, den wahrscheinlich günstigsten Nordpolweg."

I have also much interesting news of other North-polar expeditions of this year, and already keep a complete journal of them. I have almost ready a very interesting original Chart, which will be published in the next volume of the "Geographische Mittheilungen."

2.—*Letter of Lieutenant Julius Payer, of the recent German Expedition.*

This expedition has achieved a result for the exploration of the sea between Spitzbergen and Nova Zembla surpassing all expectations, and from which a greater undertaking will follow next

* Such a temperature as has never been observed in the Northern or Southern hemisphere.

† Geographische Mittheilungen, 1870, Tafel, 12.

year. Why it was not with consistency possible, nor right, to follow up one of the problems proposed, viz: to reach King-Charles-Land, Lieut. Weyprecht will explain in person. On the other hand, the discovery of an extended, open Polar sea, in the place of territory considered entirely unnavigable, and into which, even in its most southern portion, the Russians, Swedes, and also the German expedition of 1868 failed to penetrate, is calculated to give another form to the polar-question, and to afford a new and very promising basis for reaching the pole.

It is exceedingly to be regretted that the great German expedition of 1869–70 did not adopt this passage through the "Nova Zembla sea," which was previously pronounced by Dr. Petermann the most favorable for penetrating into the heart of the polar basin.

While weighty authorities, even up to our time, have declared positively against every route by the east of Spitzbergen, and while the numerous Russian expeditions, in our century, were not once even in a position to sail by the north of Nova Zembla, and in the past year, the voyage of the Norwegian Johannesen, close to the coast of this double island from the Kara sea into the Barents sea was considered an extraordinary, and, in many respects, a questionable event; our experience has proved *the existence of an extended open sea to the north of Nova Zembla.* But when also the sea was observed by the mariners Simonsen, Mattiesen, etc., this year, as too before, as almost completely free from ice, and when the former did not succeed in discovering in the neighorhood of the White Island the ice on which the capture of the walrus depends, yet in the autumn the connection of the open Nova Zembla sea with the Polynia of northern Siberia has been as good as proved. But with this discovery, an immense ice-territory disappears from our charts. It will certainly be represented that the year 1871 has been a particularly favorable one for ice-navigation, just as has often been said, wrongly and in absence of proof, of "unusually unfavorable" years. But throughout Norway the walrus-hunters and fishermen unite in calling the past summer absolutely the worst which has been known for a long time. If even the German expedition-vessel, "Germania," did not succeed in pushing farther than into the Kara sea, the cause of this backwardness of steam, compared with the ordinary sailing-vessel, is attributed, here in Norway, to the very deficient fitting of the Germania. It well be of great importance in the interest of the subject to give this ship, which, however, belongs to 1869–70, an impartial examination.

How now are we to explain the circumstances of the Polar voyage just completed, which differ so entirely from the previous one? We are so far from the presumption of imagining that we have acted with more energy and determination than others before us, that we, ourselves, do not think of desiring to place our little undertaking, as a genuine expedition, on the same footing with former ones. The solution of the riddle lies simply in this fact, that almost all expeditions to this region of the sea have started

too early and returned too early, since the most favorable time for the navigation comes in the autumn.

All of these expeditions, too, have hugged too closely, either the coast of Nova Zembla or of Spitzbergen; while it seems to be the case that the portion of the Nova Zembla sea most favorable for reaching the north lies between the 40th and 42d degrees of longitude. We have here, without trouble, reached almost to 79° N. lat., and nothing, except want of provisions, prevented our penetrating farther to the north.

The Gulf-Stream appears to be the most probable cause of this remarkable condition of the ice, in the autumn, in the Nova Zembla sea, which is not to be compared, on the whole, with that on the coast of Greenland. Until the observations already made have been brought together and compared, this cannot be asserted with certainty, but only advanced as probable. In our opinion, however, these facts bear on the subject, viz: the temperature of the water in these high latitudes (in September) exceeding that of the air by 2° to 5° C.; the prevalence of mist, and of thunder storms; the appearance of a sky peculiar to the trades; the constant current toward the north on the coast of Nova Zembla; the ultramarine-blue color of the water, characteristic of the Gulf Stream; the remarkable wealth of the waters in the inferior animals, etc. It appears, then, that in the commencement of autumn the Gulf Stream leaves the coast of Nova Zembla, and advances westward, but that then it extends over a broader surface. This layer of warm water is of unequal depth, and diminishes in strength to the north.

An economical result of this expedition is the discovery of the enormous richness of the hitherto quite unexplored Nova Zembla sea in walrusses.

The scientific work accomplished during the voyage consists of a continuous series of observations of the temperature and density of the water, at the surface and at different depths; systematic meteorological observations in regard to the occurrence of banks, driftwood, currents in a double and, in part, three-fold series of deep sea soundings, declination determinations, geological investigations, collections of plants and rocks, etc.

Coast of Norway, on board the Harald Haarfagr, Oct. 9, 1871.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On a new method of nickel-plating.*—Within the last few years a process of nickel-plating by electrolysis has been invented by Mr. Isaac Adams of Boston, and is now employed to a considerable extent in all of our large cities. Mr. Adams' process, which is patented, involves the employment of a bath of double sulphate of nickel and ammonium and of an anode of cast nickel.

The prices charged by companies working under the patent are extremely exorbitant, and as a coating of nickel is an excellent preventive against rust and injury by acid vapor, chemists will give a hearty welcome to a simple and cheap method of nickel-plating, which is open to the use of all. The process, which is due to Prof. F. Stolba, is as follows: The salt of nickel may be the chloride, sulphate, or double sulphate of nickel and potassium. It need not be chemically pure, but must contain no metals which are precipitated by zinc. In addition the operator will require a solution of chloride of zinc, obtained by dissolving commercial zinc in common chlorhydric acid, cuttings of sheet zinc, zinc-dust and pure chlorhydric acid. The process of plating may be effected in a vessel of porcelain or metal; the author prefers copper, which itself becomes plated with nickel. The articles to be plated may be of cast or wrought iron, steel, copper, brass, zinc or lead. They must be completely immersed in the liquid used for plating, and their surfaces must be perfectly free from fat and rust. Iron vessels may be cleaned by treating with a solution containing 3 or 4 per cent of chlorhydric acid. A sufficient quantity of a concentrated solution of chloride of zinc is now poured into the plating vessel, and from once to twice its volume of water added. The solution is then to be heated to the boiling point, and chlorhydric acid added drop by drop until the precipitate, formed by diluting the chloride of zinc with water, is redissolved. As much zinc-powder as will cover the point of a knife is then added, by which the metal of the vessel becomes, in a few minutes, plated with zinc wherever it is in contact with this liquid. Enough nickel-salt is then to be introduced to color the liquid distinctly green, after which the articles to be plated, and with them some small cuttings of zinc, are to be put in, care being taken to afford a sufficient number of points of contact. The liquid is then to be boiled, when the nickel is soon precipitated, and the work is finished in about 15 minutes. If particular parts of the articles are not plated, the boiling must be continued, fresh pieces of zinc, and, if necessary, fresh nickel salt, being added. It is important, if the coating of nickel is to be brilliant, that the liquid on boiling shall not be cloudy from basic zinc salt, or acid from free chlorhydric acid. The nickel-plated articles must be well washed with water and then cleaned with polishing chalk. The author found that articles of copper, plated with nickel, after several months' exposure to the atmosphere of the laboratory, appeared scarcely tarnished. It is important to remark that the same liquid may be employed repeatedly for nickel-plating, especially when chloride of nickel is employed. The same process applies to cobalt, but the coating with this metal, besides its cost, possesses no practical value.—*Polytechnisches Journal*, cci, p. 145 (July, 1871). W. G.

2. *On the direct oxidation of carbon to mellitic acid.*—At the recently held 44th meeting of German scientists and physicians, at Rostock, Prof. Schultze exhibited to the chemical section his beautiful process for the oxidation of carbon by hypermanganic acid,

in an alkaline solution. Pure wood charcoal, ignited in a current of chlorine gas, was employed. The products of this oxidation were oxalic acid in large quantity, other organic acids and mellitic acid. The identity of the acid was established by the highly characteristic reaction resulting in the formation of euchron and by distilling the acid with soda-lime. In this case benzol was formed, which was then converted into nitro-benzol and aniline. Schultze's very beautiful discovery furnishes a new synthesis of benzol and its immense and important series of derivatives, and chemists will look with great interest for the publication of the author's complete research.—*From a letter of v. Meyer in Berichte der Deutschen Chem. Gesell.*, Band iv, 1871, p. 801. W. G.

Gmelin–Kraut: Handbuch der Chemie.—All chemists will heartily welcome a new edition of Gmelin's indispensable Handbook, the inorganic portion of which has long been behind the science of the day, though still often consulted and never superceded. We have before us the first, second, third and fourth Lieferungen of the second division of the first volume, and the first and second Lieferungen of the third volume. The entire work is under the charge of Prof. Kraut, with Professors Naumann and Ritter and Dr. Jörgensen as collaborators, to ensure its rapid completion. The favorite old treatise appears with a larger and clearer page and better type, and, apparently, with no abatement of its former thorough and conscientious exhaustion of every topic treated. W. G.

Neues Handwörterbuch der Chemie.—We have also to welcome a new edition of the Handwörterbuch, the second supplement to which was completed a few years ago. The work is under the charge of Prof. von Fehling, with the assistance of nearly all the most prominent German chemists. Two Lieferungen of the first volume are published, and the entire work is to embrace six volumes. The type is much smaller than that employed in the first edition, but is clear and handsome. The new system is adopted throughout. The work promises to be a noble addition to chemical literature, but it is earnestly to be hoped that its publication will be pushed forward with all possible energy, and that, as in the earlier edition, the first volume will not be out of date before the last is begun. W. G.

II. Geology and Natural History.

1. *Discovery of a remarkable Fossil Bird;* by Professor O. C. Marsh. (From a letter to Professor Dana, dated San Francisco, Cal., Nov. 29th, 1871.)—One of the treasures secured during our explorations this year was the greater portion of the skeleton of a large fossil bird, at least five feet in height, which I was fortunate enough to discover in the Upper Cretaceous of Western Kansas. This interesting specimen, although a true bird—as is clearly shown by the vertebræ and some other parts of the skeleton—differs widely from any known recent or extinct forms of that class,

and affords a fine example of a comprehensive type. The bones are all well preserved. The femur is very short, but the other portions of the legs are quite elongated. The metatarsal bones appear to have been separated. On my return, I shall fully describe this unique fossil under the name *Hesperornis regalis.*

2. *Occurrence of Diamonds in Xanthophyllite;* by P. v. JEREMEJEW.—In the xanthophyllite of the Schischimskian Mountains, near Slatoust, v. Jeremejew has observed diamonds of varying size irregularly distributed through the plates of the mineral. When magnified 30 diameters they are readily recognized, and with 200 diameters their crystalline form is seen to be that of the hexa-tetrahedron 3-$\frac{3}{2}$, combined with the tetrahedron, the faces of the first form being distinctly convex, those of the latter flat [like fig. 59 in Dana's Min., p. 21, except that there are also small flat planes of the tetrahedron]. Most of the crystals are colorless and quite transparent; some have a pale brown tint. They are symmetrically disposed in the matrix, their trigonal intermediate axes being vertical to the foliation of the xanthophyllite. The green plates of this mineral, nearest the rounded masses of talcose slate and serpentine, enclose unusually large numbers of them, and they are likewise found in the two rocks themselves.—*Jahrbuch für Mineralogie*, 1871, p. 275.

3. *Triassic Sandstone of the Palisade Range.*—The composition of this rock from New Jersey localities, as obtained by Dr. P. Schweitzer, is given on page 459 of the last volume of this Journal, and the name felsite was cited from the same paper, as proposed by Prof. Henry Wurtz. In a letter recently received from Prof. Wurtz, we are informed that he has not applied that name to the rocks. He has a communication on the subject in the Proceedings of the N. Y. Lyceum of Natural History for Nov. 14, 1870, containing his own analyses and giving the same feldspathic constitution essentially to the rock. He found the shaly beds to have a density of 2·84, and inferred that they consisted essentially of disintegrated mica. He states in his letter that Dr. Schweitzer's analyses were made at the instigation of Dr. Newberry, with a view to test the ideas previously deduced by him. He questions whether the albitic character of the material of the sandstone may not be owing to the alteration of oligoclase to albite, and purposes to further investigate this point.

4. *Geological Survey of India.*—Volume III, Nos. 1 to 8, of the Palæontologia Indica connected with the Geological Survey of India, issued in 1870 and 1871, in all 410 pages 4to, with many plates, contains an account of the Cretaceous Pelecypoda of India, by Ferd. Stoliczka, Paleontologist of the Survey; the plates, 28 in number, are full of good figures. Vol. IV, Part I, contains a memoir, by Prof. Huxley, on the Vertebrate fossils of the Panchet rocks.

Volume VII. of the Memoirs of the Survey (8vo) treats of the Vindhyan Series in the N. W. and Central Provinces, by F. R. Mallet; of the Mineral Statistics of India, by Thos. Oldham, the Director of the Survey; Geology of the Shillong Plateau, by

H. B. Medlicott; and on the Kurhurbari, Deoghur and Karanpura Coal-fields, by T. H. Hughes.

The Records of the Survey which have appeared once in three months, contain many valuable papers on the Geology and productions of India, some of them illustrated by maps.

5. *Friderici Welwitschii Sertum Angolense.* 4to, pp. 94, tab. 25. Part 1 of vol. xxvii of the Transactions of the Linnean Society, 1869.—The most remarkable plant of a truly extraordinary flora is that which commemorates its discoverer, the *Welwitschia mirabilis*, which Dr. Hooker fully illustrated in a former volume of the Linnean Transactions. Of this strangest of plants, and of Dr. Hooker's almost exhaustive treatise upon it, we rendered some account at the time. Dr. Welwitsch now publishes a selection of a goodly number of very interesting plants from his Angolan and Benguelan collections, chiefly new genera or remarkable species; and the excellent plates are from drawings by Fitch. Upon some of the plates the aspect of the whole plant is delineated, e. g., *Pachypodium Lealii* and *Sesamothamnus Benguellensis* which, with some most bizarre species of *Vitis* and with *Welwitschia* itself, make the principal part of a queer pigmy-tumid arborescent growth, in a region too arid for ordinary vegetation. Another subject, *Acanthosicyos horrida*, is a Cucurbitaceous shrub, spiny and nearly leafless, with somewhat the aspect of a Furze or Broom, which in these same deserts bears a grateful acidulous fruit, larger than an orange, and sometimes as large as an ostrich's egg; the fleshy and oily seeds of which are also edible. As a solitary exception to the rule that all *Cacteæ* are American, *Rhipsalis Cassyta* is proved to be indigenous to a long stretch of tropical Africa; and we are now informed that our *Brasenia peltata*, having been found already in Oregon, Japan, N. E. India and Australia, has been detected in tropical Africa, solely in lake "Ivantalla," 5,000 feet above the Atlantic coast and about 120 geographical miles in the interior. Another North American genus, until now monotypic, is unexpectedly found to have an African representative, in *Brunnichia Africana*, discovered at a cataract in a wooded district, less than 2,500 feet above the level of the sea. *Pilostyles Æthiopica* represents another American type. As all the species known before are parasitic upon Leguminous shrubs or trees, this also grows upon *Berlinia paniculata*, a Cæsalpineous tree. *Aristida prodigiosa*, a grass which flourishes on the sandy hills of the most arid of regions, on account of its grayish hue hardly distinguishable from the sand in which it grows, furnishes the sole support of multitudes of zebras, antelopes, &c., throughout the long dry season. The force of Linnæus' remark, that there was always something new and strange coming from Africa, is not yet exhausted. A. G.

6. *Hooker's Icones Plantarum.* Third Series, vol. 1, part 4. January, 1871.—This completes the first volume of the revived Icones Plantarum, of which ten volumes (a thousand plates) were

published by Sir William Hooker. We received and duly noticed the first two parts of the new issue. The third part, by some mishap, has not been received, which we regret the more on account of its containing some new genera of Sandwich Island *Rubiaceæ*, in which our interest is renewed since Dr. Hillebrand has brought hither, and is now elaborating, his large recent collections of Hawaian plants. The most interesting plants of the part now before us are the following: *Ranunculus limoselloides*, of New Zealand, which "mimics," as the expression goes, a *Limosella*. *Chalepoa Magellanica* Hook. f, a Fuegian plant, with much the habit of *Diapensia* or rather *Pyxidanthera*, which has been for years somewhat known, and has puzzled the few botanists who have examined it, but only now published, and, for lack of any happier guess, is doubtfully referred to the *Pittosporeæ*. *Raphanocarpus Kirkii* Hook. f, an African Cucurbitaceous plant, which, with one erect and one suspended ovule, confirms the idea already entertained, that the primary divisions of this order in the new Genera Plantarum are not so well founded as could be wished. *Phyllacanthus Grisebachianus* Hook. f, the plant of C. Wright's Cuba collection named by Grisebach *Catesbæa phyllacantha*. *Brackenridgea Zanguebarica* Oliver, a second species, so far confirming the genus. A. G.

7. *Structure of the Pistil in Primulaceæ.*—Van Tieghem, upon his first study of the ovary of *Primula*, &c., finding that the vascular bundles of the free central placenta were disposed in a circle in a homogeneous parenchyma, adopted the apparently prevalent view that this placenta belongs to the axis and not to the carpels, this arrangement being that characteristic of stems. But further and more scrutinizing observations show that this conclusion does not follow. Without known exception, the vascular and woody bundles of stems have their spiral vessels on their inner face, their liber or bast cells on the outer face, i. e., presented to the circumference of the stem. Now Van Tieghem finds that the bundles in the placenta of *Primula* and other plants of the same order (as likewise in *Caryophyllaceæ*, &c.) present their liber-cells inward, their spiral vessels outward, contrary to the manner of vascular bundles of stems. These bundles originate in connection with those which pass into the ovarian walls, and which correspond to the margins of the five carpels; passing into the placenta they ramify, and the ovules are borne at their terminations. He then examined the outer floral whorls in cases where their parts produce an accessory piece or appendage on the inner face or at its base, such as the petals of *Ranunculus*, of Oleander, the crown of the perianth of *Narcissus*, the stamens of *Cobæa*, &c. In all these the vascular bundles of the internal appendage or crown equally have their liber-cells facing toward the axis of the flower, their spiral vessels turned from it. Van Tieghem therefore concludes that, as these accessory pieces are appendages or deduplications of the petals, stamens, &c., so the free central or basilar placenta consists of internal appendages or deduplications of the

carpels; also that each ovule answers to the lobe of a leaf. See Ann. Sci. Nat. for 1869, published in 1871. In a following paper, on *The Anatomy of the Flower of Santalaceæ*, Van Tieghem demonstrates an analogous structure in the flower of *Thesium* and *Osyris*, and draws the conclusion that each ovule, one for each of the three carpels, is the termination of an internal appendage or *talon* of a carpel. From a corresponding study of the vascular bundles of the sepals and superposed stamens, he likewise infers that the stamen is not autonomous, but is theoretically a petiolate internal appendage of the sepal behind it. Thus he homologizes the blossom of *Thesium*, &c., with that of Mistletoe, in which, according to his view (as already mentioned), the stamen and sepal, also the ovule and the carpel, each answer simply to one leaf; in the Mistletoe confounded without distinction farther than that the inner face is polleniferous or ovuliferous, according to the sex; in *Santalaceæ* a differentiation into separate organs, the ovule being here a separate and special lobe of the carpel. Thus, he concludes, disappears another example of so-called axile placentation, as it falls under the general law which he expresses essentially as follows:—The embryo-sac is always a cell of the parenchyma of a carpellary leaf; the ovule which contains this sac is always a lobe or part of the tissue of this leaf—more or less transformed, more or less separated from the rest of the leaf. A. G.

8. *Tieghem, Comparative Anatomy of the Cycadaceæ, Coniferæ, and Gnetaceæ.*—The principal results of this investigation (communicated to the French Academy of Sciences, published in Ann. Sci. Nat. for 1869) are given by the author in a *resumé* in Bull. Soc. Bot. France, March, 1870. To determine whether the ovules or whatever they be, are borne on a leaf or a branch, Tieghem examined the distribution of the vascular bundles, in the same manner as in his later investigations upon the placenta of Primula and the flowers of Mistletoe. This new evidence led him unequivocally to the conclusion, that

Cycadaceæ are gymnospermous; the leaves, produced directly on the axis of the female bud, develop ovules on their margins, so that each is an open free carpel.

Coniferæ also have naked ovules borne upon a leaf, but not upon leaves of the primary axis, i. e., upon bracts of the first order. The ovules are always borne upon the dorsal face of the first and only leaf of an axillary branch, which is therefore an open carpel, constituting the female flower. This leaf is always inverse, i. e., is directly opposite the subtending bract, so that this bract and the carpellary leaf face each other. The principal variations of this universal plan are the following.

This axillary branch reduced to its first leaf, and ovuliferous, is commonly of the second generation; but sometimes of the third (*Cephalotaxus* and *Taxus*), or even of the fourth generation (*Torreya*).

The carpellary leaf bears the ovules either on its base (*Thuja*, *Cupressus*, &c.), or on its middle (*Pinus*, *Sequoia*, &c.), or toward

its summit (*Cunninghamia*, &c.); the ovules thus correspond each to the lobe of a leaf. In other cases the ovules terminate the leaf; then each half of the blade may be transformed into an ovule (*Ginkgo*, *Cephalotaxus*), or the whole blade may be transformed into a single ovule (*Taxus*, *Phyllocladus Podocarpus*); sometimes the petiole is much lengthened (*Ginkgo*), but oftener it is very short, and the carpellary leaf is then wholly transformed into two ovules (*Cephalotaxus*), or into a single one (*Podocarpus*).

The carpellary leaf is distinct throughout its whole length in *Pinus*, *Ginkgo*, *Podocarpus*, &c. Sometimes a sheath of parenchyma unites the vascular systems of the opposed bract and carpel more or less, so that they may be free only at the summit (*Thuja*, *Cupressus*, &c., *Sequoia*, *Arthotaxis*, &c., *Araucaria*, *Dammara*, &c., *Darydium*). The difference here is like that between superior and inferior ovary, so that one may say that certain *Coniferæ* have a free or superior, others an inferior or adherent ovary.

It follows that *Coniferæ* form one indivisible natural family,—are all reducible to one and the same type.

Gnetaceæ are half way between the ordinary *Gymnospermæ* and other Phænogamia. *Ephedra* has an ovary, indeed, but it is an open one, and without style or stigma. It is gymnospermous as to fecundation, as the action of the pollen upon the ovule is direct; but angiospermous as to fructification, as the fertilized ovule undergoes its transformations within a closed cavity, proper to each flower, and formed by the infolding of the leaf to which the ovule belongs.

Such are the principal features of a view which throws new light upon the morphology of the Gymnospermous plants, vindicates their claim to this name, and carries throughout a high probability of its essential correctness. A. G.

9. *Van Tieghem, Anatomy of the flowers and fruit of Mistletoe* (*Viscum album*).—Upon this subject the distinguished Dutch Vegetable Anatomist has published in Ann. Sci. Nat., ser. 5, t. 12, an elaborate and interesting, albeit considerably theoretical, paper, following up the line of research, and the ideas which he had pursued with great advantage in his earlier memoir on the floral structure of Gymnosperms, and determining whether an organ is of cauline or of foliar nature by studying the plan of the arrangement of its vascular bundles. Van Tieghem stoutly maintains that ovules in all cases pertain to a carpellary leaf, never to the axis; that the ovule is not an axis nor a bud, nor yet an organ *sui generis*, but is a dependance of a leaf,—a lobe (as it were) of a carpellary leaf transformed, to protect the embryo-sac and to aid in its fecundation; that in *Viscum* this ovule is reduced to the greatest possible simplicity, viz: to its essential part, the embryo-sac. His main conclusions are,—

(1.) That the male flower consists of four simple leaves only, that is, of two decussate pairs, each polliniferous upon the superior or inner face, and not of 8, as before supposed, i. e., 4 sepals and 4 stamens superposed to and connate with them.

(2.) In the female flower the ovule is reduced to an embryo-sac, which is a cell of the parenchyma of the base of the upper face of the third pair of bracts, i. e., the carpels. A. G.

10. *Clarence King's Geological Exploration of the 40th Parallel: Botany*, by SERENO WATSON, aided by Prof. DANIEL C. EATON and others. Illustrated by a map and 40 plates. Washington: Government Printing Office, 1871. pp. 525, 4to.—We propose to notice this volume particularly: indeed it well deserves a more thorough examination and more extended review than our time and space will now allow us to devote to it. It is published "by order of the Secretary of War, under the authority of Congress," as one of the Engineer Corps series, has been carefully edited and beautifully printed, so that the volume is every way an attractive one. Errors of the press are to be found, but they are apparently few, and the whole typography is remarkably excellent for the Government Printing Office. Our comparison is naturally with corresponding volumes of the Pacific Rail-Road Survey, and of the Mexican Boundary Survey, upon which the present volume is a notable improvement. The forty plates, filled with well chosen subjects, if not of the very highest style, are so well done and of such excellent promise that the name of the draughtsman (who is new to this class of work, we believe), Mr. J. H. Emerton, of Salem, Mass., should properly have been appended to them.

The General Report, of 53 pages, forms a separately-paged introduction to the "Catalogue," as it is termed, with excessive modesty, i. e., the systematic account of the plants collected, which makes up the principal bulk of the volume. This General Report will naturally be most interesting to general readers and naturalists, but no less so to special botanists. It is thoroughly readable matter; and we expect to see it reproduced in the scientific journals. Four or five pages sketch the geographical features of the region, tersely and clearly. But, when a stream of water is said to "become *demoralized* with alkali and is lost," we could wish that this popularized use of the word were buried with it. The meteorological notes, with tabulated observations by thermometer, evaporator, &c., are equally interesting, displaying the dryness of the Great Basin, its cold winters, and hot summers. The notes on the general character of the vegetation picture to us the botanical aspect of the region, the relative prevalence of the predominant species, the slow and cross-grained growth of what timber there is in the cañons, &c. A dead branch, apparently of *Pinus monophylla*, 8 inches in diameter, had the fibres so twisted that in 7 feet they made four complete circuits. A saw-mill in Ruby Valley offered the opportunity of ascertaining the age and dimensions of several specimens of *Pinus flexilis* from the upper cañons of the Humboldt Mountains; sections from 22 to 30 inches in diameter showed from 400 to 486 annual rings. The "everlasting sage-bush," *Artemisia tridentata*, displayed 65 rings on a section 8 inches in diameter, 37 upon 4 inches, &c. A *Juniperus occidentalis* 12 inches in diameter showed 250 rings. *Cercocar-*

pus ledifolius, it appears, may form a trunk of 2 feet in diameter, with 160 rings. The alkaline species, aquatic and meadow species, those of the drier valleys and foot-hills, the mountain species, &c., are separately enumerated; the introduced species, about 30 in number, are recorded, and finally the number of indigenous genera and species is given under their orders, and their distribution in the basin or over the borders on either side is tabulated. Of the 1141 species of the basin and of the Wahsatch and Uintas, 60 per cent. appear to inhabit also the Pacific slope, about 60 per cent. are not found east of the Rocky Mountains, 15 per cent. only approach the Mississippi or the Saskatchawan, 25 per cent. approach the Atlantic, 17 per cent. are Mexican or southern, and nearly 15 per cent. are Arctic.

A few pages at the close are devoted to the consideration of the agricultural resources of the basin, the limit to which is fixed by the deficiency of water. "The most fertile localities lie at the base of the sierras; but, as a rule, there is an apparent absence everywhere of a true soil or mould resulting from the decomposition of vegetable matter." A moderate amount of alkali in the soil appears not to be detrimental to culture. The soil which produces "sage bush" seems to be always cultivable when it can be irrigated. With the present supply of water, most economically used, it is thought that only one thousand out of 34,000 square miles of Northern Nevada could be brought under cultivation; of the southerly portion and of Western Utah much less. Eastern Utah, with larger and more constant supplies of water from the Wahsatch and the Uinta mountains, is much more favorably situated. The absence of graminivorous animals, excepting rabbits in the valleys and rarely a few mountain sheep or antelopes in the higher ranges, shows that the country is ill adapted for grazing. *Eurotia lanata* and a few other chenopodiaceous plants are eaten by sheep as a substitute for grass.

Mr. Watson raises the question whether—considering the amount of low shrubby and perennial vegetation which inhabits the plains and thrives without irrigation,—these plants themselves, or some more serviceable substitutes equally adapted to the climatic conditions, may not be turned to some profitable account under the necessities of a future population; and whether, in time to come, some forms of orchard, vineyard, or tree culture may not possibly be made to thrive in that region. He finds that the present plants on the whole are not lacking in expansion of foliage or succulence, at least that the more prevalent plants had an average of from 55 to 80 per cent of foliage or working surface; and a series of rough, but seemingly well devised experiments demonstrated that they give off by evaporation daily an amount equal to three-eighths of the weight of their available material. Dry as the soil appears to be, it is this, and not the atmosphere that must furnish the supply to make good this loss. Yet water is rarely to be had under a depth of 100 to 300 feet, often not even at that depth. The

porous soil must allow of the free upward diffusion of moisture, also of deep penetration of the roots from above.

An excellent map is given, exhibiting the district from above the 42d parallel to below the 39th, on which the routes of the three several years are traced in colored lines, and the mountain ranges with the general configuration of the surface represented. We will endeavor hereafter to review the systematic part of this work. A. G.

11. *Prof. Oliver's Flora of Tropical Africa*, vol. ii (Reeve & Co., London, 1871), has just been received. It comprises the Polypetalous orders from *Leguminosæ* to *Ficoideæ* inclusive. The first of these orders fills over half of the volume; the Papilionaceous portion is by Mr. Baker, the other suborders, both largely and interestingly represented, are by Prof. Oliver himself. Of *Cæsalpinieæ* in particular there are several remarkable and peculiar genera. Prof. Oliver also elaborated the *Rosaceæ* and *Saxifragaceæ*, which are scanty, as well as other small families; Mr. Britten, one of the promising assistants at Kew, now transferred to the British Museum, has done the *Crassulaceæ;* Professor Lawson of Oxford, the *Combretaceæ* and the few *Myrtaceæ:* Dr. Hooker, the *Melastomaceæ*, which are considerable; Mr. Hiern of Cambridge, the *Lythraceæ;* Dr. Masters, the *Samydaceæ* and *Passifloreæ;* Dr. Hooker, the *Cucurbitaceæ*, which are represented by 34 genera, also the *Begoniaceæ;* and Prof. Oliver concludes with the somewhat miscellaneous group named *Ficoideæ*. The contrast continues notable between the miscellaneous character of Tropical African Botany, and the most peculiar character, richness and great diversity of South African vegetation. A. G.

12. *Heer: Flora Fossilis Arctica. Die Fossile Flora der Polarländer*, 2ter Band mit 59 Tafeln. 4to. (Winterthur, Würrter & Co., 1871.) This second volume of Heer's Arctic Fossil Flora is a collection (with title page, preface and index) of the following papers:—

(1.) *Contributions to the Fossil Flora of North Greenland, being a Description of the Plants collected by Mr. Edward Whymper during the summer of* 1867. This is from the Philosophical Transactions of the Royal Society, London, 1869, and is in English, illustrated by 18 plates.

(2.) *Flora Fossilis Alaskana*, with 10 plates. This is a paper contributed to the Transactions of the Royal Swedish Society of Sciences, Stockholm, 1869. It is in Latin, with a preface in German.

(3.) *Der Miocene Flora und Fauna Spitzbergens*, &c., with 16 plates—from the Transactions of the same society. This is in German, but with Latin diagnoses of species.

(4.) *Fossile Flora der Bären Insel*, with 15 plates—from the same Society's Transactions, 1870: in German and Latin. The plants described are of the coal formation.

The very interesting results which these memoirs contain have already been brought to our notice in this Journal. A. G.

13. *On Kansas Vertebrate Fossils.*—Prof. E. D. Cope has given a brief account, in the Proceedings of the Philosophical Society of Philadelphia, October, 1871, of some fossil vertebrates in the collections of the State Agricultural College of Kansas. They include the following species:

Liodon dyspelor Cope, now for the first time announced as a Kansas species; a species of Liodon near *L. proriger* Cope, and another near *L. ictericus* Cope; *Liodon latispinus* Cope, a new species of large size, nearly equalling the *L. Mitchillii*, that is 40 or 50 feet long; *Clidastes Wymanii?* Marsh; *Clidastes cinerarium* Cope; Ichthyodectes near *I. ctenodon* Cope; *Anogmius contractus*, a new genus and species, near *Ichthyodectes* in the vertebræ wanting lateral grooves, but like those of *Saurocephalus* in having the basal elements of the neural and hæmal elements not coössified with the centrum; a *Saurocephalus* near *prognathus* of Cope.

Professor Cope also gives brief notices of some fossils observed by himself on an excursion in the valley of Smoky Hill River, in Kansas. On Butte Creek a large part of the skeleton of a monster saurian, the *Liodon dyspelor* Cope, was exhumed. On the same bluff another Liodon and a Clidastes were discovered, with some fossil fishes. In neighboring bluffs, bones supposed to be those of a *Pterodactyl*, of two species of *Clidastes*, a *Dinosaur*, a Crocodile and of numerous fishes were brought to light.

At a similar location on Fox Creek, M. V. Hartwell found the skeleton of a very large fish, with "uncommonly powerful offensive dentition," probably of the Saurodonts. He names this Cretaceous species *Portheus molossus.* In the same region the very slender bones of a reptile were obtained, probably of the Testudinates, which he named *Protostega gigas.* The remains of a large *Liodon proriger* Cope, were found scattered, "his huge truncate, browsprit-like snout betraying his individuality at once;" also others of several species of *Clidastes.* Near Russel Springs, on the Smoky Hill, twenty-six miles distant, a large *Clidastes* was found, also bones of *Liodon ictericus* and of two new Clidastes.

Prof. Cope adds that the giants of this Cretaceous sea were the *Liodon proriger* Cope, *L. dyspelor* Cope, *Polycotylus latipinnis* Cope, and *Elasmosaurus platyurus* Cope. Of these, the first was apparently the most abundant; the second was the longest, exceeding in length perhaps any other known reptile; the last named had the most massive body, and exhibited an extraordinary appearance in consequence of the great length of its neck.

14. *Illustrated Catalogue of the Museum of Comparative Zoölogy.* No. IV. *Deep-Sea Corals;* by L. F. de Pourtalès. Cambridge, 1871. 93 pp. quarto, with eight lithographic plates.—In this work, all the stony corals which have been dredged during the several expeditions made by the U. S. Coast Survey for the purpose of exploring the bed of the Gulf Stream, off Florida, are fully described, and most of them are beautifully figured. The work is not only the most complete account that has yet appeared

of any group of deep-sea animals, but is also a very valuable contribution to the history and classification of corals. A large number of new forms, both of genera and species, are described, and important points in the structure and affinities of certain genera and species are discussed at length. It is accompanied by tables of the distribution of the species in depth, and the appendix contains an enumeration of the shallow water and reef-corals of Florida, with valuable notes upon their synonymy, modes of occurrence, etc.

The introduction contains a history of the expeditions, together with an account of the configuration and character of the bottom along the several lines of soundings and dredgings.

The whole number of corals obtained from deep-water is 48, of which three were dead, and probably accidentally transported from shallow waters. Of these, 28 species occurred at depths exceeding 200 fathoms, and 17 below 300 fathoms, though several of the latter were perhaps transported from somewhat shallower waters. Of reef-corals 49 species are enumerated, two of which are Millepores, belonging to the Hydroidea.

In several instances the writer would disagree with Mr. Pourtalès in reference to the synonymy of species and higher groups, as well as in respect to their affinities and classification, but a discussion of these points would lead too far for the present occasion. In general the classification of Milne Edwards and Haime has been followed, but several important and judicious changes have been adopted from others, and some new ones have been introduced. Among others the following points seem to require special notice. Turbinolidæ of E. and H., as adopted by Mr. Pourtalès, is erroneously made synonymous with Caryophyllidæ Verrill.* The latter included only a part of the former group, the second part having been made a family under the former name. Stylophoridæ had previously been characterized as a family by the writer in the work referred to in the note. In the same work the writer has shown the necessity of uniting the Cladocoraceæ and Astrangraceæ into a single family, the distinctions being hardly of generic value, and yet they are still kept apart by Mr. Pourtalès. The family Stylasteridæ Gray (emended), is fully discussed on page 32, and some additional facts of importance are given in regard to their structure. The observation that they have finely porous corals is new and interesting, and with other characters renders it probable that they should be referred to the Madreporacæ (Perforata of Edwards and Haime), as suggested by the author, who however hesitates, apparently unnecessarily, to make the change. We may add that other characters, making this view still more probable, are the small number of septa, and the depth and narrowness of the cells, and consequent elongation of the polyps,—features very characteristic of the Madreporaceæ. The polyps are still unknown in all the genera of this family. Although agreeing with Mr. Pourtalès in regarding the Eupsammidæ as a group of full

* Transactions Connecticut Academy, vol. i, p. 535, 1870.

family rank, we do not see any reason for separating it very widely from the Madreporidæ or in approximating it to the Turbinolidæ. The resemblances to the latter are very superficial, while it is united to the former by many intermediate forms. To *Isophyllia Guadulpensis* (p. 71), *I. rigida* Verrill is referred as a synonym, on the ground that it is not the *Astræa rigida* Dana. The latter identification is, however, correct, and was made after a careful examination of Dana's type. which had the septa and walls considerably worn. Ellis and Solander are given as the authority for *Mœandrina clivosa* Verrill, but their name was *Madrepora clivosa*. The name *Astræa* should be adopted instead of *Favia* (p. 75), for *A. rotulosa* was made the type of the genus by Lamarck in 1801 when it was first proposed, and he mentioned only one other species (*A. radians*) which he referred to a second division of the genus and which now forms the type of the genus *Siderastræa*, belonging among the Fungians. We see no reason whatever for supplanting the oldest name of the latter species (S. radians) by a later one, as has been done by Mr. Pourtalès.

Among the genera now first made known as belonging to the fauna of Florida and the West Indies are *Fungia*, *Dendrophyllia*, *Astrocœnia* and *Colangia*, the last a new genus allied to *Phyllangia*. A. E. V.

III. Astronomy.

1. *On the mean motions of the four outer Planets.* (Extract from a letter of Prof. Benjamin Peirce to Prof. Newton, dated Dec. 13th, 1871.)—I have discovered three fixed equations between the mean motions of the four outer planets. If the mean motions of Jupiter, Saturn, Uranus and Neptune are respectively represented by n^{v}, n^{vi}, n^{vii} and n^{viii}, these equations are

$$4n^{vi} + 9n^{viii} = 16n^{vii}$$
$$2n^{v} + 17n^{vii} + 6n^{viii} = 12n^{vi}$$
$$3n^{vii} + 8n^{viii} = n^{v}$$

Of the fixedness of the first of these equations I have no doubt; and am almost equally certain of the second, but feel rather more doubt concerning the third. Their reception involves a laborious revision of the theory of these planets, which I cannot hope to have the strength to accomplish, and must seriously change the elements of their orbits. If all the three equations are admitted, the mean motions of three of these planets can be computed when the fourth is given. Thus, I find

$$n^{v} = 109256''\cdot719\ (1+\lambda)$$
$$n^{vi} = 44001''\cdot8054(1+\lambda)$$
$$n^{vii} = 15428''\cdot1822(1+\lambda)$$
$$n^{viii} = 7871''\cdot5215(1+\lambda)$$

in which λ is a correction to be ascertained after the revision of the theories.

If the third equation is rejected, the other two will give the mean motions of two of the planets when two are known. I have found in this case,

$$\begin{aligned} n^{v} &= 109256''{\cdot}719 + 249\lambda \\ n^{vi} &= 43996''{\cdot}127 \quad\quad + 249\lambda' \\ n^{vii} &= 15425''{\cdot}172 - 18\lambda + 132\lambda' \\ n^{viii} &= 7868''{\cdot}694 - 32\lambda + 124\lambda' \end{aligned}$$

in which λ and λ' are corrections to be determined after the revision of the theories. I presented my argument concerning the establishment of these equations to the American Academy last evening. Even if they should be finally rejected, it is evident that in the present uncertainty, the corresponding planetary inequalities are so exceeding long, and of such uncertain length, that it will be necessary to present the corresponding perturbations in the same way as if they were exact.

2. *The Eclipse.*—The telegraph informs us that the eclipse observations on the 12th of December were successful, the weather being very favorable.

The expedition from England under the charge of Mr. Lockyer was destined for Jaffua in the island of Ceylon. It was joined upon the way by Jannsen and Respighi, from which we presume that the original design of the former to go to Java was given up.

It was expected that East Indian expeditions would occupy one or two stations near the Malabar coast, and one near Trichmopoly. Also expeditions from Australia to the line of the eclipse across the northern part of that continent were projected, and probably carried out.

3. *Star Maps—Suggested Improvement;* by E. S. Martin, Wilmington, N. C. (Communicated.)—All those who use star maps to any extent, and without the benefit of an assistant, have felt the inconvenience and loss of time incurred by leaving the telescope to consult the map. And as the light used to illume the maps causes the pupil of the eyes to contract, when a return to the tube is made nothing can be distinctly seen. Especially is this the case when any small stars or faint objects are under examination.

The following method is suggested as, in a measure, capable of remedying the trouble. Instead of stamping the stars on the map, as usual, let punctures be made, differing in size, so as to represent the different magnitudes. When a map thus prepared is spread out, and a light set behind it, all those punctures shine as stars. The eyes suffer no inconvenience from increase of light, and if the map is placed at or near the instrument, one eye may view the map, while the other looks into the tube. Thus a comparison may be made without much effort.

In order to better direct the eye where to look, in a blank sheet of paper, cut a hole the size of the field of view of the telescope, and place this sheet over the map. As successive portions of the heavens are brought into view by the rotary motion of the earth, slip this sheet along. Where wires are used in the instrument,

threads may be stretched across the hole in the paper, and thus further assist the eye in the comparison of the map with the heavens.

The writer has himself profited much by this arrangement, he having punctured a common star map for the purpose.

4. *The Wisconsin Meteorite;* by I. A. LAPHAM.—Two additional fragments of this meteorite have been discovered, since the notice in this Journal,* one of 16¼ pounds in 1869, the other 33 pounds in 1871, making a total of 143 pounds. These last present the same external characters, and doubtless have the same chemical composition; the six fragments were all found in the same field.

5. *New Comet.*—A comet (1871, V.) was discovered at Milan, by Tempel, on the 3d November. It was small and faint, and with a declination of 9°25′ south (R. A. $18^h\ 37^m{\cdot}9$) was moving rapidly southward. The following elements are given by Oppolzer in the *Astron. Nachr.*, Nov., 1867, from the observations of the first four days.

$$T = \text{Dec. } 20{\cdot}1155 \text{ mean Berlin time.}$$
$$\left.\begin{aligned} \pi &= 22^\circ\ 25'\ 39'' \\ \Omega &= 145^\circ\ 19'\ 53'' \\ i &= 102^\circ\ 7'\ 40'' \end{aligned}\right\} \text{mean eq. 1871.}$$
$$\log q = 9{\cdot}87628$$

The resulting ephemeris gives a south declination of 37° 4′ on the 5th of December.

6. *Magnetometer Indications on September 7th;* by C. A. YOUNG (dated Hanover, Nov. 14, 1871).—Immediately after the remarkable solar disturbance of which a description was given in the last number of the Journal of Chemistry, a letter was addressed to the Greenwich Observatory, requesting information as to the behavior of the magnetic instruments at that moment. In due time, but too late for insertion last month, a courteous reply was received from Professor Airy, inclosing tracings from the photographic record-curves of the declinometer, and of the horizontal and vertical force magnetometers. These are shown in the cut below.

Contrary to my expectation, there was no specially marked disturbance of the magnets *simultaneous* with the "explosion" (if explosion it really was). It is not impossible that the small disturbances indicated on the first and second curves were really caused by it.

Professor Airy writes: "The day was one of magnetic disturbance, but it does not appear that any remarkable movement coincided with the beginning of your observation. There was a sudden movement nearly at the end."

About 2½ hours after the "explosion," the magnetic storm began which developed into the beautiful aurora of that evening.

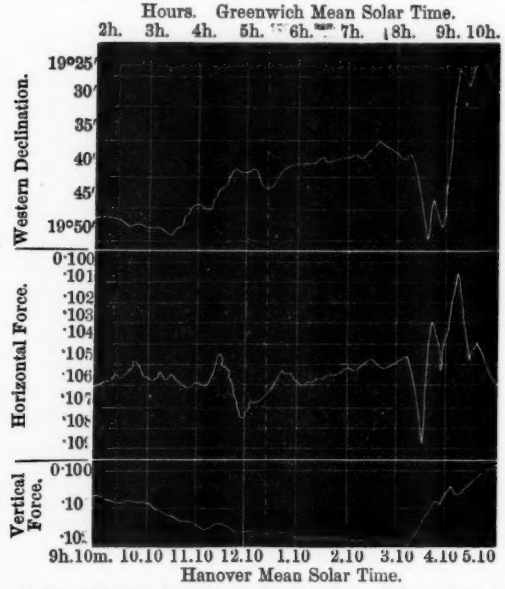
It would seem accordingly either that considerable time is occupied in transmitting a magnetic perturbation from the sun to the earth; or else, what is perhaps more probable, that mere *mechanical* movements in the solar atmosphere, such as the phenomena in question appears to have been, are less efficacious in disturbing

* Vol. xlvii, p. 271, March, 1871.

our magnetometers than certain other actions which are less conspicuous.

Royal Observatory, Greenwich.

Magnetic changes, Sept. 7, 1871, *from* 2*h. to* 10*h.*



The vertical dotted line indicates the probable time of the explosion, 12h. 40m Hanover time.

While there can be no possible doubt that there is a close connection between the condition of the solar surface and magnetic disturbances on the earth, much further investigation will be required to elucidate the matter.—*Boston Journal of Chemistry, December*, p. 68.

7. *The first Appendix to the Washington Observations for* 1869, being Reports on observations of the total solar eclipse of Dec. 22d, 1870, by the observers of the U. S. N. Observatory, has just been published. Prof. Newcomb arranged to observe at Gibraltar the transits of the sharp cusps of the solar crescent across the wires of a telescope, in order to obtain materials for correcting the lunar theory. The telegraphic determination of the longitude of Gibraltar, which is necessary to the completion of his purpose, was not possible at the time owing to an unfortunate break in the cable. Profs. Hall, Harkness and Eastman, at Syracuse, made successful and detailed observations for time, and upon the nature of the light of the corona and prominences.

Prof. Harkness concludes an extended discussion by proposing this theory of the corona. "When seen in a clear sky the corona

is a purely solar phenomenon, produced by a vast body of self-luminous gas,—not improbably incandescent vapor of iron,—which envelopes the sun and is erupted from it in the same manner as the red prominences."

The observers were aided by Capt. Tupman of the British Navy, whose report is also given.

8. *Annals of the Dudley Observatory.* Vol. II.—This second volume of Annals of the Dudley Observatory contains the descriptions of the several self-recording meteorological instruments constructed by the Director, Mr. Hough, a series of hourly observations of barometric pressure during five years, with other meteorological records made at the observatory. In the appendix are observations on the total eclipse of Dec. 1869, on the meteors of Dec., 14th, 1867, &c., and the several annual reports of the Director to the Board of Trustees. Thirty-six charts are added, exhibiting the changes from day to day of the meteorological phenomena during the years 1868–70.

9. *Astronomische Tafeln und Formeln;* by C. F. W. Peters, Hamburg, 1871. (W. Mauke.) 8vo, 233 pages.—This series of tables is for the use of observers with fixed or portable instruments, and for general astronomical computations. It consists of nearly forty numerical tables, followed by a dozen pages of trigonometric and astronomic formulas. Some of the tables are like those in *Warnstorff's* edition of *Schumacher's Hülfstafeln*, but there are many new ones, and most of the old ones are recomputed or enlarged. The volume includes tables for conversion of mean into sidereal time, arcs into time, degrees, &c., into arcs; tables for computing parallax, nutation, aberration, figure of the earth, reduction to the meridian, refraction; also Ruhlmann's hypsometric tables, a very conveniently arranged table of squares of numbers, up to 10,000, for use in the method of least squares, a table of natural sines, tangents and secants, to five decimals for each minute of the quadrant, an interpolation table for use when 2d, 3d, 4th and 5th differences are employed, and tables for reduction of barometers of various scales.

10. *The American Ephemeris and Nautical Almanac for* 1874 is just out, two years in advance.

IV. Miscellaneous Scientific Intelligence.

1. *Masses of Meteoric Iron.*—At the meeting of the Geological Society held on the 8th inst., there was read a letter from the Embassy at Copenhagen, transmitted by Earl Granville, mentioning that a Swedish scientific expedition, just returned from the coast of Greenland, had brought home a number of masses of meteoric iron found there upon the surface of the ground. These masses varied greatly in size; the largest was said to weigh 25 tons. Mr. David Forbes having recently returned from Stockholm, where he had the opportunity of examining these remarkable masses of native iron, took the opportunity of stating that

they had been first discovered last year by the Swedish arctic expedition, which brought back several blocks of considerable size which had been found on the coast of Greenland. The expedition of this year, however, has just succeeded in bringing back more than twenty additional specimens, amongst which two were of enormous size. The largest, weighing more than 49,000 Swedish pounds, or about 21 tons English, with a maximum sectional area of about 42 square feet, is now placed in the hall of the Royal Academy of Stockholm; whilst, as a compliment to Denmark, on whose territory they were found, the second largest, weighing 20,000 lbs., or about 9 tons, has been presented to the Museum of Copenhagen. Several of these specimens have been submited to chemical analysis, which proved them to contain nearly 5 per cent. of nickel, with from 1 to 2 per cent. of carbon, and to be quite identical in chemical composition with many aërolites of known meteoric origin. When polished and etched by acids, the surface of these masses of metallic iron shows the peculiar figures or markings usually considered characteristic of native iron of meteoric origin. The masses themselves were discovered lying loose on the shore, but immediately resting upon basaltic rocks (probably of Miocene age), in which they appear to have originally been imbedded; and not only have fragments of similar iron been met with in the basalt, but the basalt itself, upon being examined, is found to contain minute particles of metallic iron, identical in chemical composition with that of the large masses themselves, whilst some of the masses of native iron are observed to enclose fragments of the basalt. As the chemical composition and mineralogical character of these masses of native iron are quite different from those of any iron of terrestrial origin. and altogether identical with those of undoubted meteoric iron, Prof. Nordenskjold regards them as aërolites, and accounts for their occurrence in the basalt by supposing that they proceeded from a shower of meteorites which had fallen down and buried themselves in the molten basalt during an eruption in the Miocene period. Notwithstanding that these masses of metallic iron were found lying on the shore between the ebb and flow of tide, it has been found, upon their removal to Stockholm, that they perish with extraordinary rapidity, breaking up rapidly and falling to a fine powder. Attempts to preserve them by covering them with a coating of varnish have as yet proved unsuccessful; and it is actually proposed to preserve them from destruction by keeping them in a tank of alcohol. Mr. Maskelyne then stated that the British Museum already possessed a specimen of this native iron, and accounted for its rapid destruction on exposure by the absorption of chlorine from terrestrial sources, which brought about the formation of ferrous chloride. This was particularly marked in the case of the great Melbourne meteorite in the British Museum; he had succeeded in protecting this, as well as the Greenland specimen, by coating them externally, after previously heating them gently, with a varnish made of shellac dissolved in nearly

absolute alcohol. He considered it probable that a meteoric mass falling with immense velocity might so shatter itself as to cause some of its fragments to enclose fragments of basalt, and even to impregnate the neighbouring mass of basalt with minute particles of the metallic iron: but he considered the question of meteoric origin could only be decided by examining the same mass of basalt at some greater distance from the stones themselves, so as to prove whether the presence of such metallic iron was actually characteristic of the entire mass of the rock.—*Chemical News*, *Nov.* 17.

2. *On the Phosphorescence of the Eggs of the common Glow-worm;* by M. JOUSSET.—On the 16th of July last, in very warm weather, I collected in the part of the Château de Monjay two glowworms which shone brilliantly. These two females were coupled, and escorted by a supplementary male. I carried them to Paris in a glass tube; and the next day they laid about sixty eggs, of the size of a pin's head, which is very large in comparison with the size of the insect.

The shell of these eggs is so delicate that they cannot be touched without breaking it. The micropyle is very apparent; and their colour is yellowish.

It is worthy of note, and, as far as I know, has not yet been indicated, that these eggs are endowed with a bright phosphorescence. They are not only phosphorescent immediately after laying, but they remain phosphorescent. Those which I collected as above, presented the phenomenon without any diminution until the 23d of July—that is to say, for seven days.

I could not continue the observation any further, because, having left the tube containing them open, I found them dried up.

If one of these eggs is crushed in the dark, the liquid which spreads upon the glass is phosphorescent, and continues luminous until it is quite dry.—*Comptes Rendus*, September 4, 1871, p. 629. *Ann. Mag. Nat. Hist.*, IV, viii, 372.

3. *Coast Survey Deep-Sea Dredging Expedition.*—The general organization and plan of this expedition is stated in Vol. II. of this Journal, on page 228. The vessel—the steamer *Hassler*—has finally sailed, having left Boston on the 3d of December. The expedition is under the command of Captain P. C. Johnson, and Messrs. Kennedy and Day are the lieutenants. On account of the lateness of the season, the projected work in the Atlantic will be mostly given up, and probably be performed another season by the *A. D. Bache*, a consort of the *Hassler*. A letter from Prof. Agassiz to Prof. B. Peirce, Superintendent of the Coast Survey, dated the day before the sailing of the expedition, has been published, announcing in a prophetic way what discoveries the expedition may be expected to make through its deep-sea dredgings in the Southern Ocean and elsewhere. The idea, that Tertiary, Cretaceous and earlier types may be looked for in the depths of the ocean, has animated all the more recent dredging expeditions, and the success in this direction has been regarded as their greatest triumph. In view of this success, Prof. Verrill observed, in

this Journal, vol. xlix, 134 (January, 1870): "The discovery of the living Cystidean, noticed in the last number of this Journal, is another fact of the same kind, and so remarkable that it may not seem unreasonable to anticipate hereafter the discovery of living Ammonites and Trilobites." The new expedition, if its plans are carried out, may do much toward ascertaining whether such predictions are to be verified or not.

4. *Jay's Cabinet of Shells.*—The very extensive collection of shells of Mr. John C. Jay, comprising 14,000 species and 50,000 specimens, has been generously given by him to the American Museum of Natural History, established in the Central Park, New York. The letter of Mr. Jay, announcing the gift, is dated November 1st.

OBITUARY.

CHARLES BABBAGE, the author of the "ninth" Bridgewater Treatise, inventor of the calculating machine, and author of various memoirs on mathematical and physical subjects, died on the 20th of October last.

There is no fear that the worth of the late Charles Babbage will be over-estimated by this or any generation. To the majority of people he was little known except as an irritable and eccentric person, possessed by a strange idea of a calculating machine, which he failed to carry to completion. Only those who have carefully studied a number of his writings can adequately conceive the nobility of his nature and the depth of his genius. To deny that there were deficiencies in his character, which much diminished the value of his labours, would be useless, for they were readily apparent in every part of his life. The powers of mind possessed by Mr. Babbage, if used with judgment and persistence upon a limited range of subjects, must have placed him among the few greatest men who can create new methods or reform whole branches of knowledge. Unfortunately the works of Babbage are strangely fragmentary. It has been stated in the daily press that he wrote eighty volumes; but most of the eighty publications are short papers, often only a few pages in length, published in the transactions of learned societies. Those to which we can apply the name of books, such as "The Ninth Bridgewater Treatise," "The Reflections on the Decline of Science," or "The Account of the Exposition of 1851," are generally incomplete sketches, on which but little care could have been expended. We have, in fact, mere samples of what he could do. He was essentially one who began and did not complete. He sowed ideas, the fruit of which has been reaped by men less able but of more thrifty mental habits.

It was not time that was wanting to him. Born as long ago as the 26th of December, 1792, he has enjoyed a working life of nearly eighty years, and, though within the last few years his memory for immediate events and persons was rapidly decaying, the other intellectual powers seemed as strong as ever. The series of publications which constitute the real record of his life commenced in 1813

with the preface to the Transactions of the Analytical Society, a small club established by Babbage, Herschel, Peacock, and several other students at Cambridge, to promote, as it was humorously expressed, the principles of pure D-ism, that is, of the Leibnitzian notation and the methods of French mathematicians. Until 1822 Mr. Babbage's writings consisted exclusively of memoirs upon mathematical subjects, which, however little read in the present day, are yet of the highest interest, not only because they served to awaken English mathematicians to a sense of their backward position, but because they display the deepest insight into the principles of symbolic methods. His memoir in the "Cambridge Philosophical Transactions" for 1826, "On the Influence of Signs in Mathematical Reasoning," may be mentioned as an admirable example of his mathematical writings. In this paper, as in many other places, Mr. Babbage has expressed his opinion concerning the wonderful powers of a suitable notation in assisting the human mind.

As early as 1812 or 1813 he entertained the notion of calculating mathematical tables by mechanical means, and in 1819 or 1820 began to reduce his ideas to practice. Between 1820 and 1822 he completed a small model, and in 1823 commenced a more perfect engine with the assistance of public money. It would be needless as well as impossible to pursue in detail the history of this undertaking, fully stated as it is in several of Mr. Babbage's volumes. Suffice it to say that, commencing with 1,500*l.*, the cost of the Difference Engine grew and grew until 17,000*l.*, of public money had been expended. Mr. Babbage then most unfortunately put forward a new scheme for an Analytical Engine, which should indefinitely surpass in power the previously-designed engine. To trace out the intricacies of negotiation and misunderstanding which followed would be superfluous and painful. The result was that the Government withdrew all further assistance, the practical engineer threw up his work and took away his tools, and Mr. Babbage, relinquishing all notions of completing the Difference machine, bestowed all his energies upon the designs of the wonderful Analytical Engine. This great object of his aspirations was to be little less than the mind of a mathematician embodied in metallic wheels and levers. It was to be capable of any analytical operation, for instance, solving equations and tabulating the most complicated formulæ. Nothing but a careful study of the published accounts can give an adequate notion of the vast mechanical ingenuity lavished by Mr. Babbage upon this fascinating design. Although we are often without detailed explanations of the means, there can be little doubt that everything which Mr. Babbage asserted to be possible would have been theoretically possible. The engine was to possess a kind of power of prevision, and was to be so constructed that intentional disturbance of all the loose parts would give no error in the final result.

Although for many years Mr. Babbage entertained the intention of constructing this machine, and made many propositions, we can

hardly suppose it capable of practical realisation. Before 1851 he appears to have despaired of its completion, but his workshops were never wholly closed. It was his pleasure to lead any friend or visitor through these rooms and explain their contents. No more strange or melancholy sight could well be seen. Around these rooms in Dorset Street were the ruins of a life-time of the most severe and ingenious mental labors perhaps ever exerted by man. The drawings of the machine were alone a wonderful result of skill and industry; cabinets full of tools, pieces of mechanism, and various contrivances for facilitating exact workmanship, were on every side now lying useless.

Mr. Babbage's inquiries were not at all restricted to mathematical and mechanical subjects. His work on the "Economy of Manufactures and Machinery," first published in 1832, is in reality a fragment of a treatise on Political Economy. Its popularity at the time was great, and, besides reprints in America, translations were published in four Continental languages. The book teems with original and true suggestions, among which we find the system of Industrial Partnerships now coming into practice. It is, in fact, impossible to over-praise the work, which, so far as it goes, is incomparably excellent. Having assisted in founding the Statistical Society of London in 1834, Mr. Babbage contributed to their Transactions a single paper, but as usual it was a model research, containing a complete analysis of the operations of the Clearing House during 1839. It was probably the earliest paper in which complicated statistical fluctuations were carefully analyzed, and it is only within the last few years that bankers have been persuaded by Sir John Lubbock to recognize the value of such statistics, and no longer to destroy them in secret. In this, as in other cases, many years passed before people generally had any notion of the value of Mr. Babbage's inquiries; and there can be little doubt that, had he devoted his lofty powers to economic studies, the science of Political Economy would have stood by this time in something very different from its present pseudo-scientific form.

Perhaps the most admirable of all his writings was the Ninth Bridgewater treatise, an unexpected addition to that well-known series in which Mr. Babbage showed the bearing of mathematical studies upon theology. This is one of the few scientific works in which the consistency of natural laws with breaches of continuity is clearly put forth. That Power which can assign laws can set them aside by higher laws. Apart from all particular theological inferences, there can be no question of the truth of the views stated by Babbage; but the work is hardly more remarkable for the profundity of its philosophy than for the elevated and eloquent style in which it was written, although as usual an unfinished fragment.

Of all Mr. Babbage's detached papers and volumes, it may be asserted that they will be found, when carefully studied, to be models of perfect logical thought and accurate expression. There is, probably, not a sentence ever penned by him in which lurked the least obscurity, confusion, or contradiction of thought. His

language was clear, and lucid beyond comparison, and yet it was ever elegant, and rose at times into the most unaffected and true eloquence. We may entertain some fear that the style of scientific writing in the present day is becoming bald, careless, and even defective in philosophic accuracy. If so, the study of Mr. Babbage's writings would be the best antidote.

Let it be granted that in his life there was much to cause disappointment, and that the results of his labors, however great, are below his powers. Can we withhold our tribute of admiration to one who throughout his long life inflexibly devoted his exertions to the most lofty subjects? Some will cultivate science as an amusement, others as a source of pecuniary profit, or the means of gaining popularity. Mr. Babbage was one of those whose genius urged them against everything conducive to their immediate interests. He nobly upheld the character of a discoverer and inventor, despising any less reward than to carry out the highest conception which his mind brought forth. His very failures arose from no want of industry or ability, but from excess of resolution that his aims should be at the very highest. In these money-making days can we forget that he expended almost a fortune on his task? If, as people think, wealth and luxury are corrupting society, should they omit to honor one of whom it may be truly said, in the words of Merlin, that the single wish of his heart was "to give them greater minds?"—*Nature, Nov.* 9.

Rev. J. A. Swan.—It is with regret that we have to announce the recent death, in Boston, of Rev. J. A. SWAN, on the 31st of October last, at the age of 48. Mr. Swan has been long known among his New England friends for his love of natural history and for his skill in the use of the microscope; and during his residence at Kennebunk, although a devoted pastor in that village, he found time to make numerous important explorations and observations in the natural history of the vicinity. Failing in health a few years ago, he visited Europe, and on his return was appointed to the responsible post of secretary of the Boston Society of Natural History, in connection with Professor A. Hyatt, succeeding Mr. Scudder in charge of the business of the society. Apart from his scientific accomplishments, Mr. Swan was endeared to all his friends by personal qualifications of the rarest merits.—X., *in Harper's Weekly.*

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *A Report of Surgical Cases treated in the Army of the United States from* 1865 *to* 1871. Circular No 3. Surgeon General Office, Washington.—The reports of the medical and surgical cases occurring in the army, and presenting the condensed tabular statements of the results of each five years, have always been looked for with interest by the profession, and more or less carefully read. The report of surgical cases, however, which has just been issued as Circular No 3, is of more than

usual importance. Instead of the statistical tables of former years, this volume contains abstracts of more than a thousand cases of surgical operations, selected as among the most interesting and instructive, and presented with details sufficient to render them extremely useful. The capital operations seem to have been remarkably successful, and the small ratio of mortality in thigh amputations (38.5) is certainly exceptional. Of the cases of punctured wounds, those by arrows are not among the least interesting, on account of their novelty in the present age, and as having furnished the occasions for the earliest recorded triumphs of military surgeons of antiquity. Of the nine cases of lithotomy, all successful, four were for calculi having for their nuclei missiles of various kinds that had perforated and lodged in the bladder; one of these being an iron arrow-head, which singularly enough had entered the bladder through the obturator forarum. The volume has been compiled by Asst. Surgeon Otis, and is a very valuable contribution to surgical literature, besides being creditable to the skill of our army surgeons.

2. *Appleton's American Annual Cyclopædia and Register of Important Events of the Year* 1870. Vol. X, 1871. Royal 8vo, pp. 789.—This volume sustains the high character of its precursors, which of course are chiefly devoted to the great interests of politics, diplomacy and commerce of the world, with special reference to details of affairs specially interesting to Americans; it touches, in an intelligent and comprehensive manner, upon the important discoveries and researches made in various departments of science. Thus we find carefully prepared articles on the following subjects: "Astronomical Phenomena and Progress;" "Aurora Borealis;" "Chemical Examination of American Grapes and Wines;" "Chemistry;" "Earthquakes;" "East River Bridge;" "Electricity;" "Geographical Explorations and Discoveries;" "Metals;" "Storm Signals;" "Eclipse of the Sun in December, 1870." The Franco-Germanic War, the important political and ecclesiastical changes in Italy, and the census of the U. States for 1870, naturally occupy a large space. These annual volumes form a permanent and most convenient record of the world's progress, and are as essential to all reference libraries as they are convenient to men of research.

3. *Boston Journal of Chemistry:* James R. Nichols, M.D., Editor, assisted by Wm. J. Rolfe, A.M.—This monthly was established in 1866, and has now reached its 6th volume. It is "devoted to the science of home life, the arts, agriculture, and medicine," and its contents, presented under these heads, are interesting and instructive to a large class of readers. It numbers among its original contributors some of our first writers, who do good service in addressing, on matters of current interest in science, a larger body of readers, than is reached by any other American journal of like character. The papers by Prof. C. A. Young on an explosion in the sun, published in the last number of this Journal, and also that on a preceding page, giving magnetometer indications at the time of the explosion, were copied from this Journal. For the use of the cut on page 70 we are indebted to its editors.

4. *An Elementary Treatise on Heat;* by BALFOUR STEWART, LL.D., F.R.S., Professor of Natural Philosophy at the Owens College, Manchester. Second edition. 12mo, pp. xx, 415. Oxford, 1871. (Clarendon Press. New York: Macmillan & Co.)—We believe we were nowise in error in regarding the first edition of this little book as altogether the best manual on the subject of which it treats to be found in any language. It is gratifying therefore to find it so well appreciated that a second edition is already demanded. The author says in his preface that he has enriched his book by the addition of those discoveries in heat which have been made since the first edition appeared; and by giving some additional problems on "Sir William Thomson's applications of the dynamical theory of heat to the establishment of relations between the physical properties of bodies." The book is brought fully up to the times, therefore; and in saying this, we have in mind the fact that its author is one of the foremost thinkers of the day in the department of the conservation of energy. We find consequently in the book a wealth of thought as entirely original as it is invaluable. The chapter on the Theory of Exchanges is incomparable; and Book III, wherein is treated the nature and sources of heat and its connection with other properties of matter, most admirably exhibits the great power and clearness with which Professor Stewart writes.

5. *A Treatise upon Terrestrial Magnetism.* 8vo, pp. viii, 179. Edinburgh and London, 1871. (Wm. Blackwood & Sons).—The object of the author in writing this book was, as he states, to advance a new theory of his own to explain the phenomena of terrestrial magnetism. He assumes at the outset, 1st, that the earth is a great magnet; and 2d, that electricity is united with the matter of which it is composed. This electricity—being attracted by all matter and at all distances—is attracted by the matter of the sun. Hence there is most electricity in that part of the earth which is directly under the sun; lessening gradually from this point in all directions. Moreover, he assumes that when a ferruginous body moves through electricity of varying density, the same effects are produced as when a current passes round such a body. On this hypothesis he proceeds to account for the phenomena of terrestrial magnetism: 1st, it follows that a current would exist over the upper part of the earth's crust, even though there are in it non-conducting portions; 2d, the arrangement of the magnetic poles is as the hypothesis requires; 3d, it explains why the magnetic poles are so distant from the terrestrial; 4th, 5th and 6th, the secular, the annual, and the diurnal variations, are thus accounted for. The book is well written, but is apparently the work of an amateur in science, who unfortunately publishes it anonymously, assuming that this would ensure it a better reception.

6. *Sur les Tremblements de terre et les éruptions volcaniques dans l'Archipel Hawaien, en* 1868; par M. ALEXIS PERREY, Prof. Hon. de la Faculté des Sciences de Dijon. 64 pp. 8vo.—Prof. Perrey continues his valuable labors in connection with the subject

of earthquakes, and here presents a review of the facts relating to the great Hawaian earthquakes of 1868. The memoir was presented to the Soc. Imp. d' Agriculture of Lyons in February, 1860. Besides the above, Prof. Perrey has also published a "*Note sur les Tremblements de terre en* 1868, *avec Suppléments pour les années antérieures de* 1843 *à* 1867, in the Proceedings of the Belgian Academy, February, 1870.

7. *Uebersicht der seit* 1847 *fortgesetzten Untersuchungen über das von der Atmosphäre unsichtbar getragene reiche organische Leben*, von CHRISTIAN GOTTFRIED EHRENBERG. 150 pp. 4to, with two plates. Berlin, Abh. d. K. Akad. der Wiss. zu Berlin, 1871.—Prof. Ehrenberg has here given a very valuable review of the facts relating to organisms from dust showers and other atmospheric sources, adding also the results of new observations. Plate I contains numerous forms of organisms from recent dust showers; that of Ispahan in 1870; the Dardanelles to Sicily in 1869; Apulia in 1868; Janina in 1870; Island of Sora in 1869; Switzerland in 1867.

8. *Crustacea Amphipoda borealia et arctica*, Auctore AXEL BOECK. 200 pp. 8vo.—A prodromus in Latin of the large work, illustrated with 32 plates, soon to be published by the author. These Amphipod Crustaceans have their greatest diversity of forms in the cold latitudes of the globe; and hence, a work on Arctic and boreal species has a special interest. This prodromus contains full descriptions of all of the species, and a complete synonymy.

9. *Elbthalgebirge in Sachsen*, von DR. HANNS BRUNO GEINITZ. —The second number of the first part of this fine work has been just issued. It treats of the corals of the Lower Quader Sandstein (Upper Cretaceous), and is illustrated by three excellent plates, 11 to 13.

10. *Die Mineralogie, leichtfasslicht dargestellt;* by FRANZ VON KOBELL. 4th enlarged edition. 272 pp. 12mo, with five plates.—An excellent manual for the young student. It is brief and precise in its descriptions, simple in its treatment of the crystallograhic and physical branches of the subject, and convenient in its classification.

11. *Revue de Géologie pour les années* 1867 et 1868, par MM. A. DELESSE et M. DE LAPPARENT. 372 pp. 8vo. Paris, 1871. (Dunod, Editeur).—This is the seventh volume of this valuable review of the progress of geological science. It was nearly com pleted nine months since, but, like much else of science in France, was interrupted, as the preface says, by the two sieges of Paris. It treats at considerable length of rocks and their metallic contents, reviews also the more important memoirs on historical geology, and also, in the last chapter, on dynamical geology.

Die Reptilfauna der Gosau-Formation in der neuen Welt bei Wiener-Neustadt; von Dr. Emanuel Bunzel. 20 pp. 4to, with 8 plates. Abh. d. K. K. geol. Reichsanstalt, Abh. V. Heft 1. Vienna, 1871.

Die Cephalopoden-Fauna der Oolithe von Balin bei Krakau; von Dr. M. Neumayr. 54 pp. 4to, with 7 plates. Ib., Heft 2.